



tony esposito

Lighting / Electrical

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Wednesday, April 4, 2012

Final Thesis Report

Hunter' Point South Intermediate School and High School
Queens, NY

Executive summary

This report provides a detailed outline and discussion of all work and analysis performed during the AE 897G senior thesis. In short, included are lighting and electrical designs for four spaces, two electrical depth topics, two breadth topics, and one MAE breadth topic. The redesigns and this report in general, is not intended to suggest that there are any problems with the existing designs of the lighting and electrical system; and all other disciplines for that matter. This senior thesis project was, however, intended to research and investigate alternative design solutions, budget-free.

The redesign of the electrical and lighting systems was performed for the following four spaces; The façade, auditorium, high school art room, and intermediate school café. See the appropriate sections for specific details on the goals and strategies of the lighting designs. The lighting redesign in general aimed to achieve a sense of connection with the building, and with the people in the surrounding neighborhood. See specific sections for elaborations.

Electrical depth 1 conducted an analysis of the distribution method with which the rooftop mechanical equipment is fed. The current method, which is to feed each piece of equipment individually from the first floor, is inefficient and cost-ineffective. In an attempt to save money, a rooftop switchboard is added to that a single feed may be routed to the roof, as opposed to the 6 previously. The redesign of the distribution system amounts to a savings of **\$205,540.83**.

The MAE breadth conducted an analysis of the available daylight in the space using the software DAYSIM 3.0. The results from DAYSIM were used to design a skylight system that supplements the shading system that was designed to block direct sun throughout the year. The addition of the skylight increased the daylight and spatial daylight autonomy of the space so that most of the points in the room met the target illuminance of 250 lux during 90 percent of the occupancy schedule.

The addition of the skylights into the high school art room introduce addition load onto the heating and cooling systems. As such, a mechanical analysis of had to be done to determine the cost implications, if any, of increasing the mechanical systems due to the increase in load. It was found that the heating system was adequate to combat the addition load, but the cooling system was not. An additional diffuser had to be added and selective ductwork upsized. The total cost increase due to the skylighting loads is **\$246.50**

Removing the drop ceiling to implement the skylights into the system required coordination of the MEP systems located in the ceiling space. The systems were modeled and coordinated in REVIT MEP 2012. It was shown that reorganizing the layout of the systems in the space decreased the obstruction of the skylights by approximately **37%**. In addition, the increase of open area of skylight amounted to an approximately 40% increase in illuminance into the space.

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Building statistics

General Building Data

BUILDING NAME | Hunters Point South Intermediate School and High School

LOCATION | Queens, NY

SITE | 1-50 51st Avenue, Long Island City

OCCUPANT NAME | NYC Department of Education (PS287 Queens)

OCCUPANT TYPE | (E) Education: Combined Intermediate School High School

SIZE | 154,000 ft²

NUMBER OF STORIES | 5 Stories

CONSTRUCTION DATE | January 10th, 2011 – October 2013

BUILDING COST | \$61,098,000

PROJECT DELIVERY | Guaranteed Maximum Price (GMP)

Project Team

OWNER | NYC Construction Authority

ARCHITECT | FXFOWLE Architects, PC

MEP/FIRE PROTECTION | Kallen & Lamelson, LLP

ACOUSTICAL / AV CONSULTANT | Cerami & Associates, LLP

GENERAL CONTRACTOR / CM | Skanska

STRUCTURAL ENGINEER | Ysreale A. Seinuk, PD

LIGHTING DESIGNER | Tillotson Design Associates

SITE-CIVIL ENGINEERING | Langan Engineering

Architecture

The Hunter's Point South Intermediate School & High School is a new, 5 story public school for grades 5 through 12. Located in the PS 287 Queens School District, Hunter's Point will house roughly 1,000 students. The building will contain 26 classrooms, 8 special education classrooms, several laboratories, library, full size gymnasium, cafeteria, kitchen, auditorium, and most architecturally significant, a nearly 4000sf roof terrace.

As part of the Hunters Point South Project (a redevelopment of the Queens area) this building will be architecturally modern, as to blend in with the new developing community. A large cantilever hovering over the roof terrace, polygonal depressions in the building, and trapezoidal shaped windows make this building architecturally interesting. Blending grey brick, slate veneer, perforated steel panels, orange aluminum composite panels, and glass curtain walls adds to the aesthetics of the building.

Zoning

Hunter's Point South School is located in zone M1-4. This zone is designated as a light manufacturing zone, which allows light industrial and public access structures. Hunter's Point South School does not have any historical significance, and thus has no special zoning requirements.

Major Codes

- New York State codes:
 - 2008 New York City Building Code
 - 2007 Building Code
 - 2007 Mechanical Code
 - 2007 Plumbing Code
 - 2007 Fire Code
 - 2007 Conservation Construction Code
 - 2007 Fuel Gas Code
- 2005 National Electric Code (NEC2005)

Façade

The building façade consists of multiple materials. On the upper floors, grey Manganese Ironspot smooth modular brick over 6" lightweight CMU was used. The first floor, with a 2" honed finished slate stone veneer, is supported by a 6" CMU wall along the north, south, and west facades.

Curtain wall glazing and windows are aluminum framed with a 1" preassembled clear annealed float glass system (comprised of a 1/8" annealed exterior sheet, 60mil polyvinyl Butyral interlayer, and 1/8" interior sheet with low-e coating). On the first and second floors, an Insulated Translucent Sandwich Panel System (ISTSPS) was used. This system allows for 15% light transmission, and has a NFRC certified U factor of 0.28. Surrounding the curtain walls are 4mm thick aluminum composite panels with cupral 913 fluoropolymer finish.

Roofing

The roof structure for this building consists of concrete on metal deck (preformed aluminum deck in some places), finished with 24"x24"x2" thick concrete paver with 4" rigid insulation. For weather resistant covering, there is a 215mil fabric reinforced, rubberized asphalt membrane.

Sustainability

Hunter's Point South School, a LEED Silver building, follows the NYC Green Schools Guide in lieu of the USGBC approach. Some notable sustainability features of this building include (but not limited to) the following:

- Occupancy Sensor controlled lighting
- Self-adjusting ventilation systems
- Solar shading
- Use of local materials (within 500 mile radius)
- Use of recycled materials

Primary Engineering Systems**Lighting**

The typical lighting system in this building consists of primarily fluorescent lighting. This is a combination of 32W linear fluorescents and 32W compact fluorescents (CFL's). In addition to these, there are a few other sources which include: incandescent, halogen, metal halide, ceramic metal halide, and LED.

There are multiple control zones used in this building, most of which are organized by space type/classification. All instruction spaces, which include IS/HS classrooms, art rooms and project rooms, are all to be controlled by a timer/occupancy sensor with manual override switch. The gym, library, auxiliary exercise, IS/HS café and student locker rooms, are all to be controlled by a timer with key override switch. The general/principal office and custodian office are to be controlled by occupancy sensor with manual override switch. All public toilets and restrooms are a timer, with no manual override switch. The lighting in the stair wells are given two zones – one for normal lights, and one for emergency lights. The emergency lights are on a timer with key override switch, whereas the normal lights are operated solely on a timer with no manual override switch. All mechanical, electrical and plumbing spaces are to be operated by a wall switch. All other interior spaces that do not fall into the previously mentioned categories are controlled with a timer/occupancy sensor or a wall switch. The following areas are all controlled by a timer/photo sensor: main entrance exterior (emergency lights), exit door exterior (emergency lights), exterior sidewalk lights and exterior roof terrace lights. The roof exterior lighting is controlled simply by a wall switch. The fire rescue area, which includes the emergency lighting, is controlled by a timer/occupancy sensor with override switch. All of the exit signs located throughout the building remains on at all times.

Electrical

This buildings electrical distribution system is a simple radial system in that there is a single entry point into the building, and everything else branches out radially from there. The main service entry point for this building is in the main electric closet located on the (plan) North wall of the building. "Main Switchboard #1 (MS1)" is the center point of this radial system. It is from MS1 that all other loads in the building are connected. The two side-

by-side electric rooms on each floor serve as the main means of routing conduit and wire. One room is dedicated to panelboards that only connect to normal power, and the other contains panelboards connected to the emergency generator. Each room contains its own riser shaft for wire and conduit. This keeps the normal power and emergency power wiring separate. The generator, located on the roof of the building in the emergency generator room, provides power to the critical building loads in the event of a power outage. Some of these loads include: emergency/egress lighting, two (2) elevators, telecom equipment, and the fire and jockey pump which are critical to the operation of the schools sprinkler system.

Structural

A geotechnical survey performed by Langan Engineering shows soil types ranging from silty sand to clay. Bedrock, consisting of Gneiss, starts at 40 feet below grade. The base floor of the building is a 12-inch, 4000 psi reinforced concrete slab on grade which is supported by grade and strap beams, steel H-piles, and 14" caissons.

The floor system in this building is 3 1/4" thick 3500 psi lightweight concrete on a 3" deep composite galvanized metal deck (18 gauge). All cast-in-place concrete slabs are reinforced with #4 gauge rebar, spaced 12" on-center.

Mechanical

Conditioned air is delivered via six air handling units (AHU's) located on the roof of the building. The first 3 units (1, 2, and 3), are variable air volume (VAV) AHU's that service the corridors, non-public spaces, office, and classrooms. The additional 3 units (3, 4, and 5), are constant air volume (CAV) AHU's that serve the gymnasium, cafeteria/kitchen, and auditorium. All of the air handling units utilize preheat coils and cooling coils with a 35% and 30% propylene glycol-water mixture, respectively.

Additional Systems

Tele/Data

There are vertically stacked telecommunication closets on each floor. These rooms are located at the rear of the elevators on each floor, and hold the primary ladder trays allowing for the vertical circulation of the system through the building. An "LON data enclose," "LDF data rack," and "IDF system backboard" in each floors telecom closet serves as the main termination point for horizontal tele/data runs. The main radial point for these is the "LON Cabinet," "Main Data Rack," and "MFD," all located in the first floor telecommunication closet.

Video Surveillance

Located in the main telecom closet on the first floor is the "Video Surveillance Equipment cabinet" and the "Main Data Rack (MDR)" that serve as the main radial point for the video security system. Located in the other telecom closets on the 2-5th floors serve as the main horizontal termination points for the dome enclosed PTZ surveillance cameras. These cameras are strategically located at the interior and exterior of all entrances to the building, as well as in the main corridors of the building.

Auxiliary Alarm

Stacked panels in the telecom closets on each floor serve the auxiliary indicator panels, low voltage push buttons, the general office auxiliary momentary program signal push buttons, and remote A/V signaling devices for the auxiliary alarm system.

Intrusion Alarm

Stacked panels in the telecom closets on each floor serve the intrusion alarm control panels, wide angle passive infrared motion detectors, long range passive infrared motion detectors, intrusion alarm siren/strobes, magnetic door contacts, and remote keypads.

Fire Rescue Intercom

The stacked electrical closets serve as the vertical circulation for the fire rescue intercom system. There are three (3) master intercom stations located in the 3rd and 4th floor principal's office, as well as the custodian's office on the first floor. Staff intercom stations are located in rooms 213, 317, 417/419, and 517.

Audiovisual

Junction boxes located in each telecom closet provides connections to the building's clock and sound system. This system serves the administrative control stations, microphone cables, loudspeaker/clock cables, privacy/call-in switches, AM/FM antennas, analog clocks, and the local sound system (which includes 2 loudspeakers and 1 microphone).

Fire Protection

This system contains both upright and concealed sprinkler heads, with a wet standpipe. Two 8" pipes leading into the building serve as the main water feed, and terminate in the Fire Pump/Plumbing/Lab Support Room on the first floor - all piping for this system is served from this room. The 1000 gpm split case pump initially pressures the system, while multiple centrifugal jockey pumps sustain the pressure in the system.

Transportation

The vertical circulation needs of this building are accomplished with four stairwells and two elevators. There is one stairwell located at the North entrance, one at the South entrance vestibule, and another in the East of the building. The North stairwell extends to the roof where the mechanical penthouse is located. There is another (smaller) stairwell that connects only the gymnasium on the first floor, and the exercise facility on the second floor. The two elevators are located in the center of the building at the intersection of the two major hallways.

Lighting

It was the original design intent of the architect to combine the two individual programs (Intermediate and High school) and the students contained within these two programs. As such, it is a main goal of my lighting design to connect the **people + programs** within this building. Such a goal is achieved by my choice of spaces, which are the spaces the architect designed specifically to be connecting points of the two programs

Second, as this building is part of a redevelopment of the Hunters Point area of Queens, it is a goal to connect the **building + community**. This can be achieved by two things: designing the façade such that neighborhood residents can freely and safely navigate the base of the building, and allowing the diverse culture of NY to influence my design.

It is the last overall goal of my lighting design to connect **lighting + architecture**. Any good lighting design is reflective of the architecture of the space. My designs aim to consider not only the physical architecture, but also the main usage, and occupant makeup of each space.

| people + programs



| building + community



| lighting + architecture



1 | Façade

This section, dedicated to the documentation of the lighting design solution for the Façade, contains all information pertinent to fully describing the space and lighting design. Included are the design goals and criteria, utilized fixtures and equipment schedules, control description, calculation summary as quantitative evaluation of the design, renderings of appropriate views, and an evaluation comparing the design solution against the design goals set at the outset of the design. This section is outlined as follows:

Description

Location

Finishes

Landscape

Tasks/Activities

Overall Design Goals

Design Criteria/Considerations

Illumination Recommendations

Design Considerations

Fixtures and Equipment

Controls

Calculation summary

Renderings

Evaluation

Summary

ASHRAE/IESNA 90.1

Description

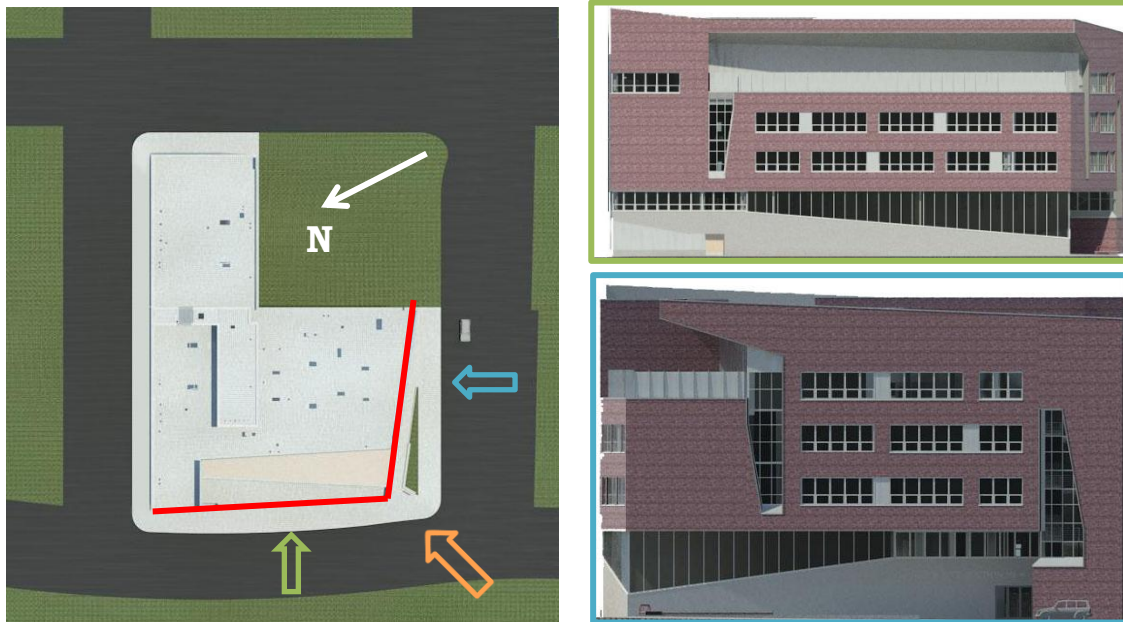
Area: $14,000 \text{ ft}^2 + 10,300 \text{ ft}^2 = 24,300 \text{ ft}^2$

Façade faces designed: Plan South, and Plan East (Highlighted in the location section below)

Façade length = 350 ft.

Location

The building is located in the square created by the intersection of four streets; Second Street to the north, Center Boulevard to the south, Borden Avenue to the east, and 51st avenue to the west. The two main (and most important) faces of the building, deemed so as they are the main entry and exit points of the building, are that which will be considered in the presented redesign. The plan below highlights the two façades—the plan south and plan east façades—that will be addressed in the redesign:

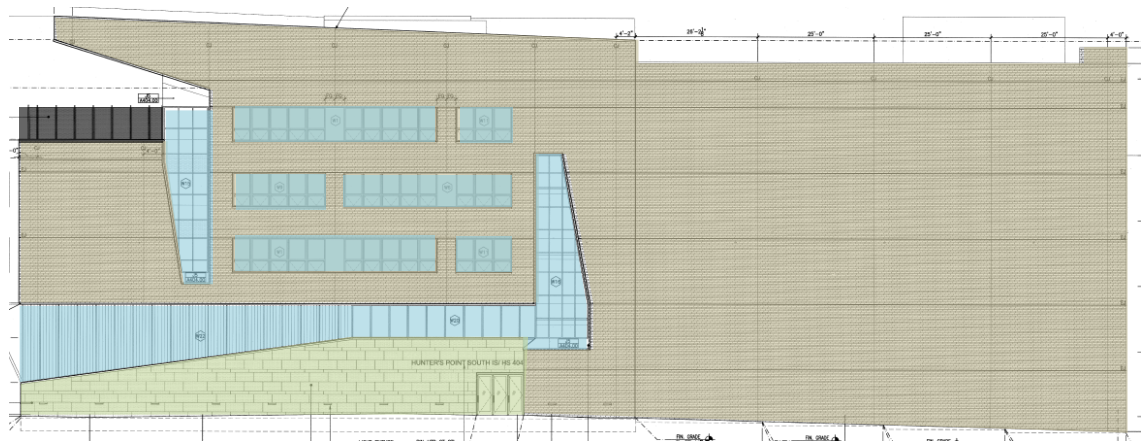
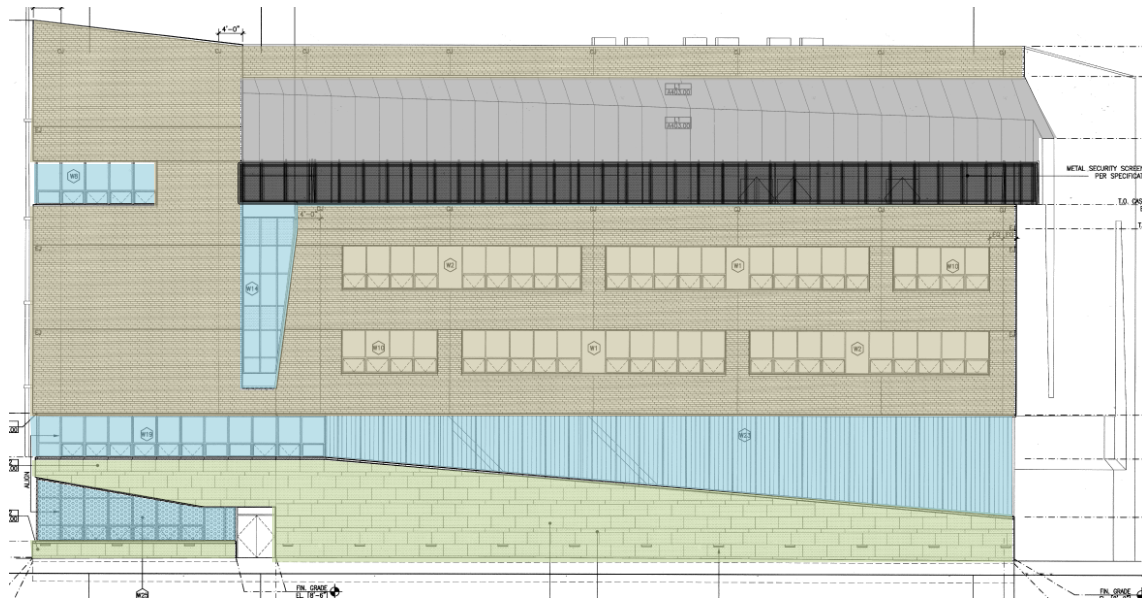







The image below shows an elevation of the building including the two faces of the façade to be redesigned:



Finishes

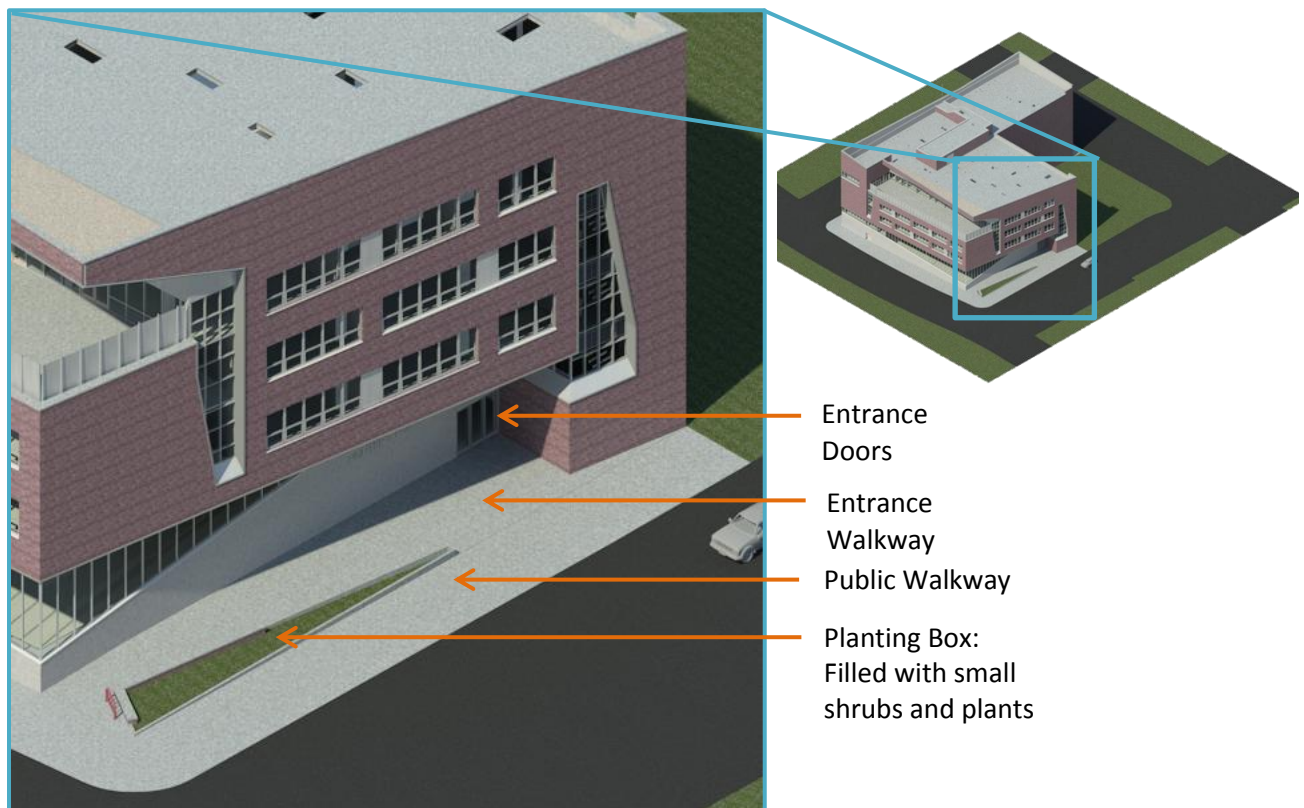
The façade of the Hunters Point School is comprised of multiple finish materials. The largest (by area) is the utility brick, highlighted in brown on the figure below. The utility brick is approximately 4"x4"x12" and is dark grey in color. The 2" exterior cut stone, highlighted in green below, wraps around the base of the building. The grey shading on the figures below represents aluminum composite panels, which comprise the overhang the sits about the large, 4500 square foot roof terrace on the fifth floor. The black area highlighted below represents the metal security screen that lines the perimeter of the fifth floor roof terrace. This security screen is grey in color, and stands approximately ten feet above finished floor (AFF). Lastly, highlighted in blue, is the glazing component of the façade. A small portion of the glazing, located on the fifth floor behind the metal security screen, is hidden from this point of view.

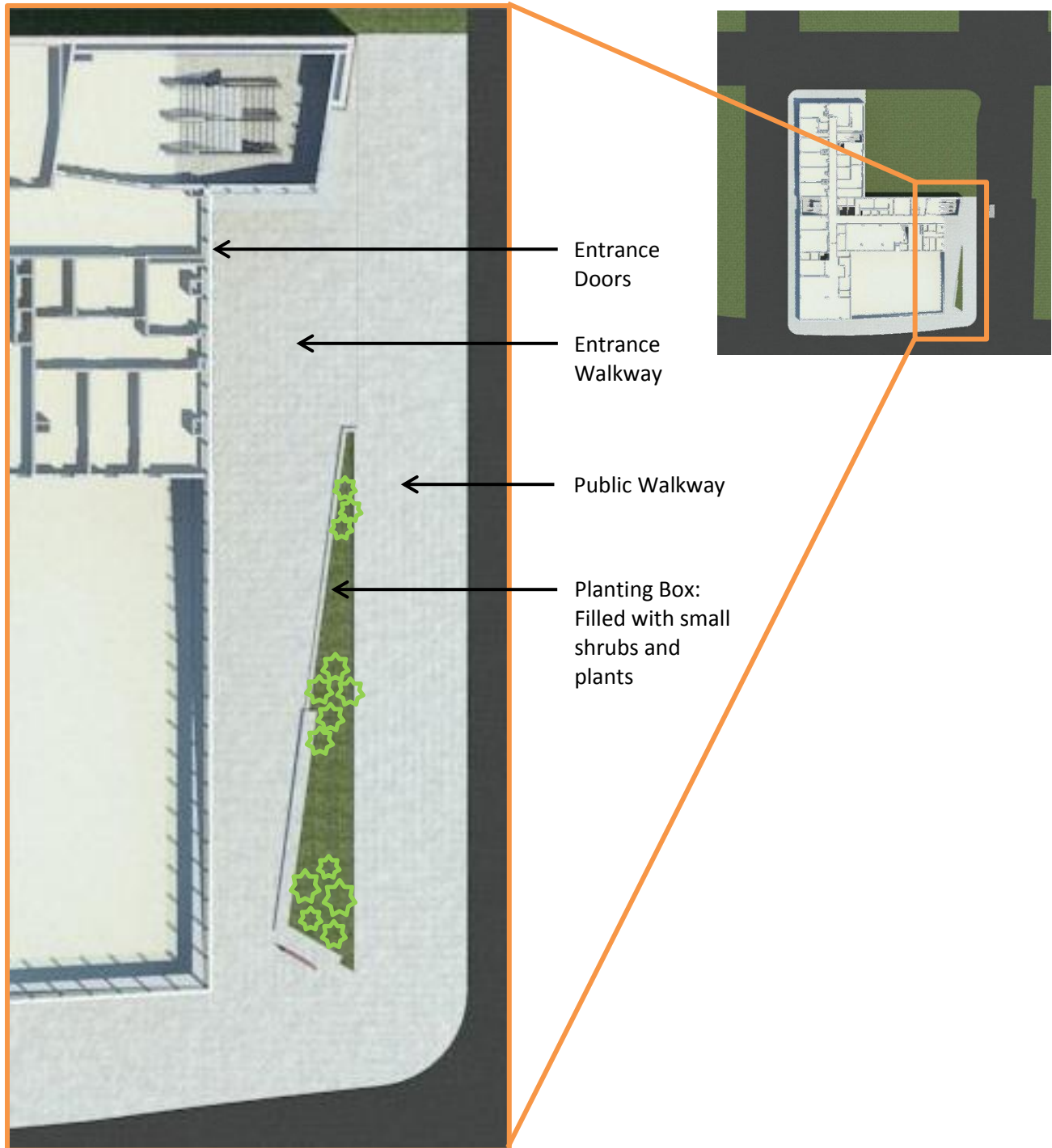


Material			
Symbol/ Swatch	Description	Style/Color	Reflectance
	3-5/8" x 3-5/8" x 11-5/8" Utility Brick	Dark Grey	0.10
	2" Thick Exterior Cut Stone	Grey	0.15
	Aluminum Composite Panel	Aluminum	0.50
	Metal Security Screen	Grey	-
	Glazing	Glass/Transparent	-

Landscape

Located near the entrance of the building, short raised brick walls—approximately 1’8” high on the entrance walkway side and 4” high on the public walkway side—enclose a small area of plants and small shrubs. The enclosure is trapezoidal, and mimics the shape of the triangular overhang directly above the public walkway.





Tasks/Activities

The exterior area of the building has no real tasks or activities besides walking around it. The building sits flush with the property line, and as such, the public walkway is directly against the façade. The small landscape planter box, which is an attempt to break up the public walkway, separates the entrance way of the building from the public walkway. Navigating around the building should be easy and engaging.

Overall Design Goals

As this building is along the riverfront, and is part of a redevelopment project of the Long Island City portion of New York, the façade and building will be very prevalent. The façade lighting should be welcoming, facilitate navigation around the building, and direct the public towards the building entrance. The design should achieve the overall design goal of connecting the **building + community**. The design goals for the façade are as follows:



Minimalistic: The design should not aim to be minimalistic in the sense that it is unimportant. Minimalistic, in terms of sustainability, means to achieve the maximum aesthetic or psychological effect with as little energy as possible.

High Visibility from River: As the building directly fronts the river, it should be easily seen from the water. It should be designed as so it is easily seen driving down the river.

Vandal Proof: As the building is located in a possible vandal zone, the lighting should be designed in such a way that it is vandal proof.

Focal Point at entrance: the entrance of the building is very small and tucked away. The lighting design should not only direct the user to the entrance, but the entrance should be a focal point of the building.

Design Criteria/Considerations

Illuminance Recommendations

Horizontal Illuminance – Important

Entrance

- IES Classification: Common Applications – Building Entries – Paths to curb – Low Activity – LZ3
 - Category C: 2 lux (0.2 fc)
 - Avg/Min: 3:1

Horizontal illuminance is important for walking the site and entering the building at night. Although there will not be heavy traffic into this building at night, it may be possible to have a few sporting events take place at this school at night. Also, where there are dances or proms, there will be a large number of students back at the building at night.

Vertical Illuminance – Very Important

Entrance

- IES Classification: Common Applications – Building Entries – Paths to curb – Low Activity – LZ3
 - Category C: 2 lux (0.2 fc),
 - Avg/Min: 3:1

The vertical illuminance at night is listed here as more important than horizontal illuminance due to the importance of facial recognition. With this building being located (possibly) in an area of mid to high crime rate, facial recognition is important.

Facade

- IES Classification: Exteriors – Facades – High Activity – LZ3
 - Category O: 100 lux (10 fc)
 - Gauge: Max

The illuminance values stated here are allotted values for key elements or details of the building. These apply to less than 25% of the building façade.

Design Considerations

Color Appearance and Color Contrast – *Somewhat Important*

As the lighting on the façade is primarily used at night, and is mostly functional, color rendering, and color in general, is of little importance. With that being said, this may depend on the weight color is put on the original lighting design. For this design, color is of little importance.

Flicker – *Somewhat Important*

Flicker itself is an important design consideration and should be avoided whenever possible. However, there is no added importance of flicker for the façade than normal. That is, there are no critical tasks that require additional attention to flicker.

Light Distribution on Task Plane – *Somewhat Important*

Sufficient illuminance should be provided on the sidewalk as to permit passer-by to walk comfortably and safely. Meeting the IES recommendations for both vertical and horizontal illuminance should be sufficient.

Modeling of Faces or Objects – *Very important*

Due to the area the building is in, vandal and crime are a possibility. The lighting should model faces very well to facilitate easy facial recognition.

Shadows – *Somewhat Important*

The façade lighting will be active primarily at night. As such, shadows are of little concern. However, facial modeling is very important. See previous section.

Special Considerations –*Very important*

As mentioned in the overall design goals of the façade, the building may be subject to vandals. The lighting, and any other system installed on the exterior of the building within reach of the public, should consider the possibility of vandalism; graffiti more specifically. The lighting shall be resistant and graffiti and impact rated.

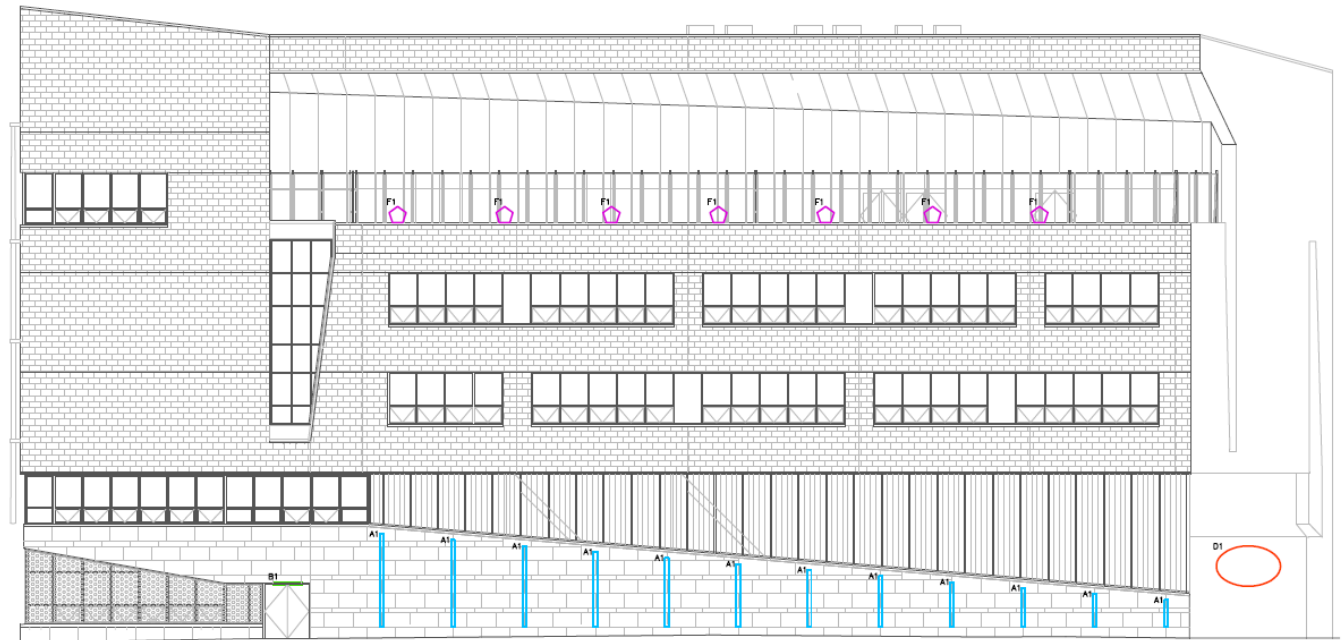
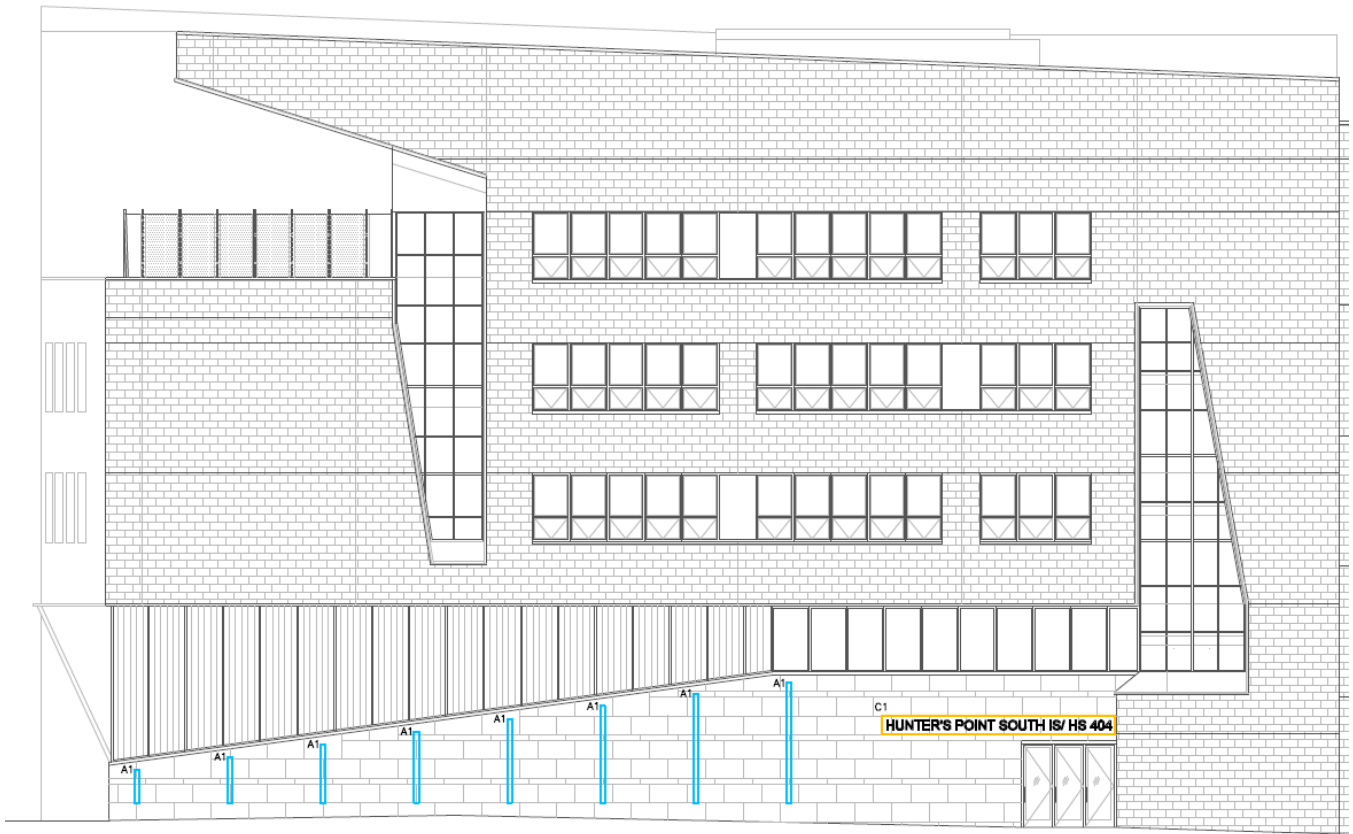
Daylighting Integration and Controls – *Somewhat Important*







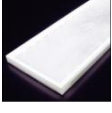



As the façade lighting will be used at night, daylight integration is not applicable. However, the lighting will be attached to the buildings time clock which is controlled by a rooftop photocell.

Glare – *Important*

Glare is important as the lighting should be unobtrusive to the buildings passers-by. Luminaires should be positioned or designed in a way as to not impose direct glare on the public.

Fixtures and Equipment



Fixture Schedule				
Type			Description	Manufacturer
A1			Recessed linear LED strip. Stainless steel luminaire housing with sealed enclosure - wet listed for exterior. 6500k white LED's. Various fixture lengths, 4W/foot.	HessAmerica
B1			Surface mounted, F32T8 direct linear fluorescent. High impact radial lense (outdoor appropriate) with tamper resistant screws. 4 foot, die-formed, gloss white (YGW) 20-gauge steel housing	Prudential Lighting
C1			Surface mounted, flexible LED strip. Super bright, white (3500K), LED's. 2.4W/ft for LED of white output.	Cooper - RSA Lighting
D1			Acrylic, 0.3 inch, surface-mounted LED lighting panel. Ellipse shaped: long radius 4'6", short radius 2'10". White (3500k) LED's. Reflective opaque white backing to maximize optical brightness	Rosco Architectural
F1			Recessed, in-ground rated, 150W PSMH floodlight. One-piece, die-cast aluminum housing, with white premium polyester powder coat paint for protection. Include top visor.	Cooper Lighting

MATERIAL FINISH KEY

3-5/8" X 3-5/8" X 11-5/8"
UTILITY BRICK SET IN
ONE-THIRD RUNNING BOND

2" THICK EXTERIOR CUT STONE

ALUMINUM COMPOSITE
PANEL

The tables below provide information regarding the energy consumption, assumed light loss factors, and load for the lamp-ballast combinations used for each of the luminaires used in the façade lighting (which includes the exterior roof terrace). The facade contains 1 linear fluorescent fixture near the exit and 242 linear feet of LED's throughout. The façade lighting consumes a total of 938 Watts (see ASHRAE/IESNA 90.1 under evaluation section).. The roof terrace, although technically considered a separate space, was included in the façade design, and utilizes 7 pulse-start metal halides. The roof terrace lighting consumes a total of 1,148 Watts.

FAÇADE VA CALCULATION								
Location	Type	Lamp	Qty	W/Fixture	Total Watts	PF	VA/Fixture	Total VA
Façade	A1	LED	168 ft	4 W/ft	672	0.7	5.7 VA/ft	960
	B1	(1) F32T8	1	38	38	0.9	42	42
	C1	LED	50 ft	2.4 W/ft	120	0.7	3.9 VA/ft	171
	D1	LED	24 ft	4.5 W/ft	108	0.7	6.4 W/ft	154
Terrace	F1	(1) PSMH	7	164	1312	0.9	182	1458

FAÇADE LIGHT LOSS FACTORS						
Type	Lamp Lumens		Light Loss Factors			
	Initial	Mean	LLD	LDD	BF	Total
A1	-	-	0.70	0.90	-	0.63
B1	3000	2850	0.95	0.90	1.20	1.0
C1	-	-	0.70	0.90	-	0.7
D1	14500	11600	0.80	0.90	1.00	0.7

ROOF TERRACE LIGHT LOSS FACTORS						
Type	Lamp Lumens		Light Loss Factors			
	Initial	Mean	LLD	LDD	BF	Total
F1	14500	11600	0.80	0.90	1.00	0.7

Controls

None of the façade lighting is controlled via occupancy sensors. All façade lighting, with a few exceptions, are connected to the buildings photocell time clock. The lighting attached to the time clock comes on at night, and shuts off in the morning. The exceptions are the fixtures located at the entrance and exit of the building. That is, the linear fluorescent over the exit of the building, and the signage at the entrance door. These fixtures are attached to the buildings emergency generator, and as such, are always on.

Calculation summary

The table below shows the calculation summary for the walkway around the building. Included in this table is the summary for 5 different calculation scenarios. The first is the vertical illuminance on the pavement. This is to ensure there is adequate illuminance for walking. The following 4 are vertical illuminance calculation to see if the vertical illuminance meets the IES requirements. There are two columns within each section (horizontal and vertical) labeled recommended and achieved. This shows the values recommended by the Illuminating Engineering Society, and the value actually achieved by design.

Façade illuminance criteria: Recommended vs. Achieved					
Category		Horizontal Illuminance (fc)		Vertical Illuminance (fc)	
Set	Quantity	Recommended	Achieved	Recommended	Achieved
Ground/ Walkway	Average	0.2	0.33	n/a	n/a
	Maximum	-	14.8	n/a	n/a
	Minimum	-	0.1	n/a	n/a
	Avg/Min	3:1	3.3	n/a	n/a
	Max/Min	-	148	n/a	n/a
Vertical 1	Average	n/a	n/a	0.2	0.18
	Maximum	n/a	n/a	-	1.0
	Minimum	n/a	n/a	-	0.1
	Avg/Min	n/a	n/a	3.0	1.8
	Max/Min	n/a	n/a	-	10
Vertical 2	Average	n/a	n/a	0.2	0.32
	Maximum	n/a	n/a	-	2.1
	Minimum	n/a	n/a	-	0.1
	Avg/Min	n/a	n/a	3.0	3.2
	Max/Min	n/a	n/a	-	21
Vertical 3	Average	n/a	n/a	0.2	0.19
	Maximum	n/a	n/a	-	0.3
	Minimum	n/a	n/a	-	0.1
	Avg/Min	n/a	n/a	3.0	1.9
	Max/Min	n/a	n/a	-	3
Vertical 4	Average	n/a	n/a	0.2	0.19
	Maximum	n/a	n/a	-	0.4
	Minimum	n/a	n/a	-	0.1
	Avg/Min	n/a	n/a	3.0	1.9
	Max/Min	n/a	n/a	-	4

The images below show the location (or area of coverage) of the sets of calculation points presented in the table on the previous page. Highlighted in red in the figure directly below is the area that was included in the Ground/Walkway calculation. This calculation was taken on the ground plane and was aimed at guaranteeing adequate illuminance levels for walking at night. The second image, with colored arrows, shows the location of the vertical calculation grids. Each arrow has a color that corresponds to the vertical calculation that it represents. The path (or line) of the arrow indicated the line along which the calculation was performed. The arrow, or direction in which it points, indicated the direction the light meter faces for the calculation. All vertical illuminance calculations were taken at 5 foot above finished grade (5' AFG).



The second image, with colored arrows, shows the location of the vertical calculation grids. Each arrow has a color that corresponds to the vertical calculation that it represents. The path (or line) of the arrow indicated the line along which the calculation was performed. The arrow, or direction in which it points, indicated the direction the light meter faces for the calculation. All vertical illuminance calculations were taken at 5 foot above finished grade (5' AFG).



Evaluation

Summary

The lighting of the exterior façade successfully achieves most of the design goals designated at the outset of design. The entrance of the building, which is small and hidden, has been highlighted with two forms of signage; the first, an LED backlit sign representing the name of the school; the second, a backlit sign showing the school's mascot. This creates a high illuminance ratio (>10:1) between the entrance and the surrounding area, which in turn, achieves the original design goal of forcing the entrance to be a focal point.

That most of the fixtures are either out of reach of the public, or are specified vandal-grade fixtures, achieves the design goal of a vandal-proof design. This was important not only for inherent cleaning cost implications of graffiti, but also because damaged or vandalized fixtures hurts the aesthetics and appearance of the building in general. The metal halide spotlights uplighting the large trapezoidal overhang on the fifth floor exterior roof terrace aims to make the building dominant on the riverfront. Persons docking boats nearby, or merely passing by on the river, should easily notice and locate the building. It may be used as a wayfinding device or landmark, and achieves the overall design goal of being visible from the river.

In general, as the façade goes over power density, the minimalistic design goal has not been achieved. Due to tradability of power densities of exterior surfaces, this is not against ASHRAE code, but it does not achieve the design goals as efficiently as maybe it could.

ASHRAE/IESNA 90.1

As mentioned in the previous paragraph, the design of the "façade" lighting does exceed the allotted power density specified by ASHRAE 90.1. The word façade is quoted because the roof terrace was included in the "façade" design, although according to ASHRAE, is a separate space. The actual façade and path-to-curb areas meet the allotted power densities as provided in the code; it is the roof terrace that exceeds its allowable power consumption. That is, because the roof terrace is an exterior space, it is considered tradable. That is, power consumption from the exterior roof terrace can be moved to the façade classification. As shown on the tables on the next page, The original

The table below shows the total input wattage for the actual façade portion of the lighting design.

FAÇADE TOTAL INPUT WATTS				
Type	Lamp	Qty	Input W	Total W
A1	LED	168 ft	4 W/ft	672
B1	(1) F32T8	1	38	38
C1	LED	50 ft	2.4 W/ft	120
D1	LED	24 ft	4.5 W/ft	108
Total:				938

The table below shows the total input wattage for the fifth floor exterior roof terrace.

ROOF TERRACE TOTAL INPUT WATTS				
Type	Lamp	Qty	Input W	Total W
F1	PSMH	7	164	1148
Total:				1148

The table below shows a comparison of the actual power consumption of the façade lighting design against the allowable consumption as designated by ASHRAE/IESNA 90.1.

Façade ASHRAE/IESNA 90.1		
Category	Allowable	Actual
Perimeter (Linear Ft.)	-	350
Input Watts (W)	1750	938
Power Density (W/ft)	5.0	2.68

The table below shows a comparison of the actual power consumption of the roof terrace lighting design against the allowable consumption as designated by ASHRAE/IESNA 90.1. As shown (highlighted in white) the roof terrace exceed allowable power density.

Roof Terrace ASHRAE/IESNA 90.1		
Category	Allowable	Actual
Area (sq.ft.)	-	4300
Input Watts (W)	688	1148
Power Density (W/sqft)	0.16	0.27

The table below shows that, although the roof terrace goes over allowable power density, it meets code when combined with the extra façade wattage.

Space	Total Wattage	
	Allowable	Actual
Façade	1750	938
Roof Terrace	688	1148
Total:	2438	2086
% Under:	14.44	

2 | Auditorium

This section, dedicated to the documentation of the lighting design solution for the auditorium, contains all information pertinent to fully describing the space and lighting design. Included are the design goals and criteria, utilized fixtures and equipment schedules, control description, calculation summary as quantitative evaluation of the design, renderings of appropriate views, and an evaluation comparing the design solution against the design goals set at the outset of the design. This section is outlined as follows:

Description

Space Location

Finishes

Furnishings

Tasks/Activities

Overall Design Goals

Design Criteria/Considerations

Illumination Recommendations

Design Considerations

Fixtures and Equipment

Controls

Calculation summary

Renderings

Evaluation

Summary

ASHRAE/IESNA 90.1

Description

Location (in building)

The auditorium, which is two stories high, in the center-point that connects the third and fourth floor of the building. It is accessible from both floors and is the point at which the two schooling types are connected. That is, the third floor houses the intermediate school students, and the fourth is dedicated to the high school students.



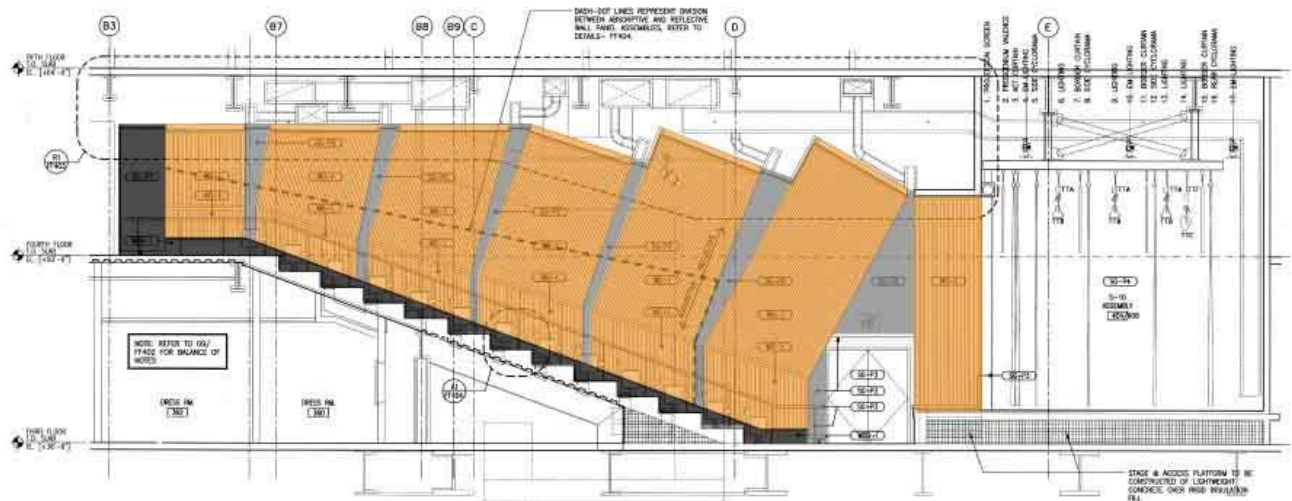
3rd Floor



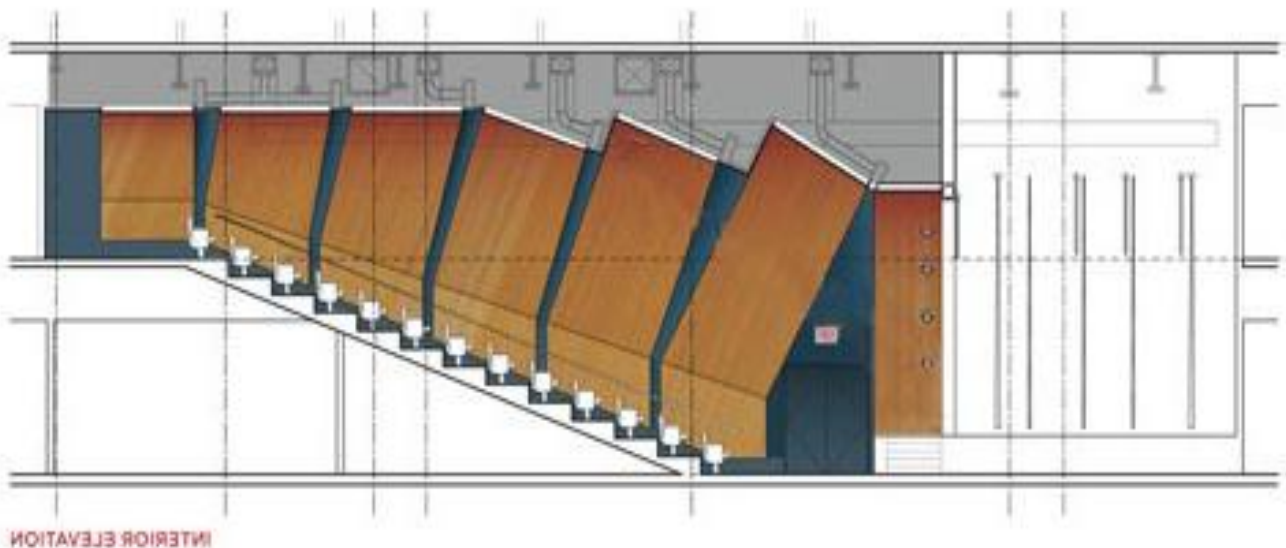
4th Floor

Finishes

The auditorium is comprised of wood paneling and painted gypsum wall board (GWB). Highlighted in orange in the figure below are the beech wood panels that are tilted at 11 degrees into the space, and are tuned acoustically so sound quality in the space is desirable. Both shades of gray in the image below represents painted GWB. The light grey is painted “evening dove” whereas the black highlight is a painted a similar shade but had a wooden baseboard. The stage and back-of-house area is also GWB painted white. Overhead panels (i.e. the ceiling) are beech wood panels as well.



The image below shows a section rendering of the auditorium space. This figure shows the color choice of the architect. You can get a feeling of how the architect imagined the space to feel.



Overall design goals

The goal in the auditorium is to achieve a flexible lighting design that can be changed depending on the event that is happening in the space. As this is an intermediate school and high school auditorium, it inherently needs to be flexible. The lighting should have the ability to be altered depending on the function of the space, and from a designers point of view, these can be labeled via the opposing Flynn impressions **public and private**. The public scenario needs to have high brightness with uniform light levels and have little to no peripheral emphasis. The public scenario should have little emphasis of particular points in general. The public scene would typically be used for large public meetings with the students. The private scenario, opposing the public scenario, should have non-uniform lighting, with emphasis on the area of importance. The private Flynn impression is typically defined by non-uniform lighting with high peripheral wall emphasis. Warm tones tend to enhance private feelings, which are further enhanced by the orange/brown wood panels lining the auditorium.

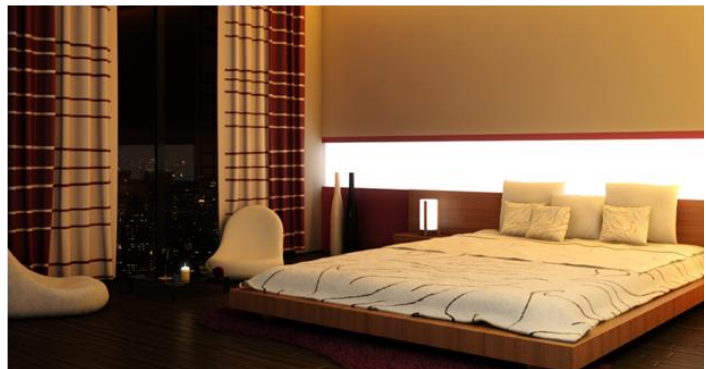
The images below graphically represent (and list) the opposing Flynn impressions.

Public



- Uniform Light levels
- High brightness
- Small to no Peripheral Emphasis

Private



- Non-Uniform Lighting
- High Brightness Remote From User
- Peripheral (Wall) Emphasis
- Warm Tones

Design Criteria/Considerations

Illuminance recommendations

Horizontal Illuminance – *Important*

- Audience

- IES Classification: Hospitality and Entertainment –Theatres, Stages –House
 - During Production
 - Category R: 1 lux (0.1 fc)
 - Avg/Min: 2:1
- IES Classification: Hospitality and Entertainment –Theatres, Stages –House
 - Pre/Post-Show, Intermission
 - Category R: 50 lux (5 fc)
 - Avg/Min: 2:1

- Circulation

- IES Classification: Hospitality and Entertainment –Theatres, Stages –House
 - During Production
 - Category R: 2 lux (0.2 fc)
 - Avg/Min: 2:1
- IES Classification: Hospitality and Entertainment –Theatres, Stages –House
 - Pre/Post-Show, Intermission
 - Category R: 50 lux (5 fc)
 - Avg/Min: 2:1

Horizontal Illuminance – Important**- Audience**

- IES Classification: Hospitality and Entertainment –Theatres, Stages –House
 - During Production
 - Category R: .5 lux (0.05 fc)
 - Avg/Min: 2:1
- IES Classification: Hospitality and Entertainment –Theatres, Stages –House
 - Pre/Post-Show, Intermission
 - Category R: 15 lux (1.5 fc)
 - Avg/Min: 2:1

- Circulation

- IES Classification: Hospitality and Entertainment –Theatres, Stages –House
 - During Production
 - Category R: 2 lux (0.2 fc)
 - Avg/Min: 2:1
- IES Classification: Hospitality and Entertainment –Theatres, Stages –House
 - Pre/Post-Show, Intermission
 - Category R: 15 lux (1.5 fc)
 - Avg/Min: 2:1

Design Considerations

Appearance of Space and Luminaires – *Very Important*

Appearance of space has been more or less dictated by the architect. However, the luminaires should be chosen so that they not only achieve the overall design goal of the space, but also that they do not conflict with the architecture.

Color Appearance and Color Contrast – *Very Important*

The surfaces in the space vary in color, and contain oranges and blues. The luminaires and lamps should be chosen with high rendering so as not to take away from the architecture.

Daylighting Integration and Controls – *Not applicable*

The space has no windows to the exterior. As such, daylighting integration and controls is not applicable to this space.

Direct and Reflected Glare – *Important*

Direct and reflected glare are important in this space especially for performance venues. The performers on the stage should not experience glare, either direct or reflected. Glare can be distracting and irritating, but in the case of an auditorium with a stage, can present safety hazards.

Flicker – *Somewhat Important*

Flicker itself is an important design consideration and should be avoided whenever possible. However, there is no added importance of flicker in this space than normal. That is, there are no critical tasks in this space that require additional attention to flicker.

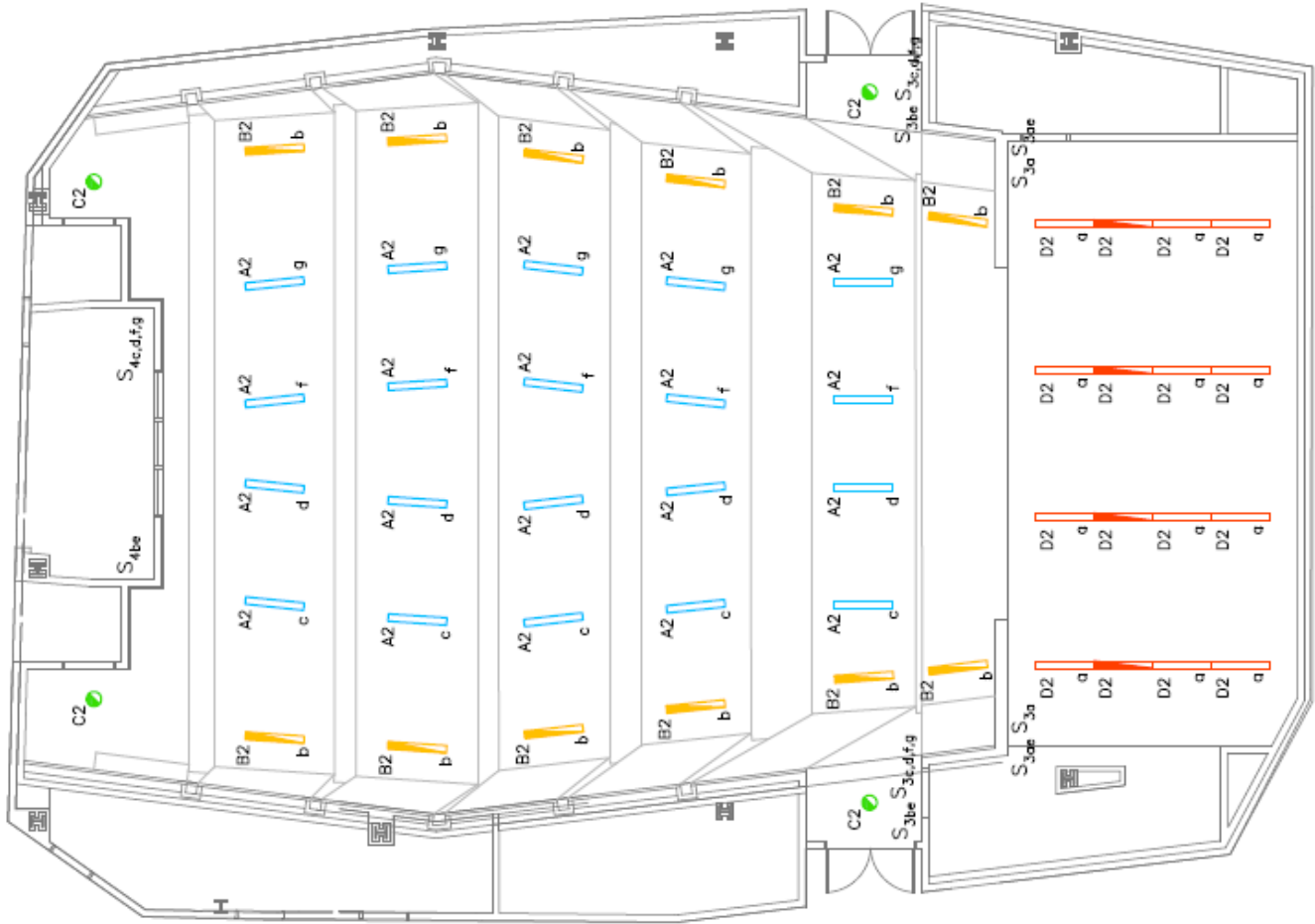
Light Distribution on Task Plane – *Somewhat Important*



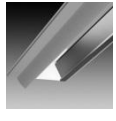





As long as the illuminance levels and uniformity meets the IES recommendations, no real problems should happen.

Shadows – *Somewhat Important*

Shadows are of little importance especially that there are few tasks in the auditorium that it could hinder. The theatrical lighting system should be designed so that shadows are implemented and extracted when desired and/or when appropriate for a performance. The general lighting in the seating area needs little regard to shadow problems.

Fixtures and equipment



Fixture Schedule				
Type	Description			Manufacturer
A2			Recessed linear fluorescent with flush .07" thick acrylic lens with opal satin finish. 22 ga. steel reflectors with high reflectance white powder coat. Matte White finish	Focal Point
B2			Recessed linear fluorescent wall-washer with flush .07" thick acrylic lens with opal satin finish. 22 ga. steel reflectors with high reflectance white powder coat. Matte White finish	Focal Point
C2			Single-lamp, recessed compact fluorescent downlight with 7 3/8" aperture. Matte white finished flange with 16 ga. aluminum, wide distribution reflector.	Lightolier
D2			Single-lamp, suspended linear T8 linear fluorescent downlight. 4' length bony of formed and welded die-formed 20-gauge steel. Gloss white (YGW) polyester power paint finish.	Prudential

The tables below provide information regarding the energy consumption, assumed light loss factors, and load for the lamp-ballast combinations used for each of the luminaires used in the auditorium lighting. The auditorium contains a total of 57 lighting fixtures (including the exit signs). The lighting solution in the auditorium consumes a total of 1,993 Watts (see ASHRAE/IESNA 90.1 under evaluation section). A light loss factor was not included for the exit sign (fixture 'EX') as it does not provide useful illumination to the room, and was not considered in any lighting calculations. It was, however, included in the energy consumption calculation of the space.

AUDITORIUM VA CALCULATION								
Location	Type	Lamp	Qty	W/Fixture	Total Watts	PF	VA/Fixture	Total VA
Auditorium	A2	(1) F32T8	20	38	760	0.9	42	844
	B2	(1) F32T8	12	38	456	0.9	42	507
	C2	(1) 32CFTR	4	36	144	0.9	40	160
	D2	(1) F32T8	16	38	608	0.9	42	676
	EX	LED	5	5	25	0.7	7	36

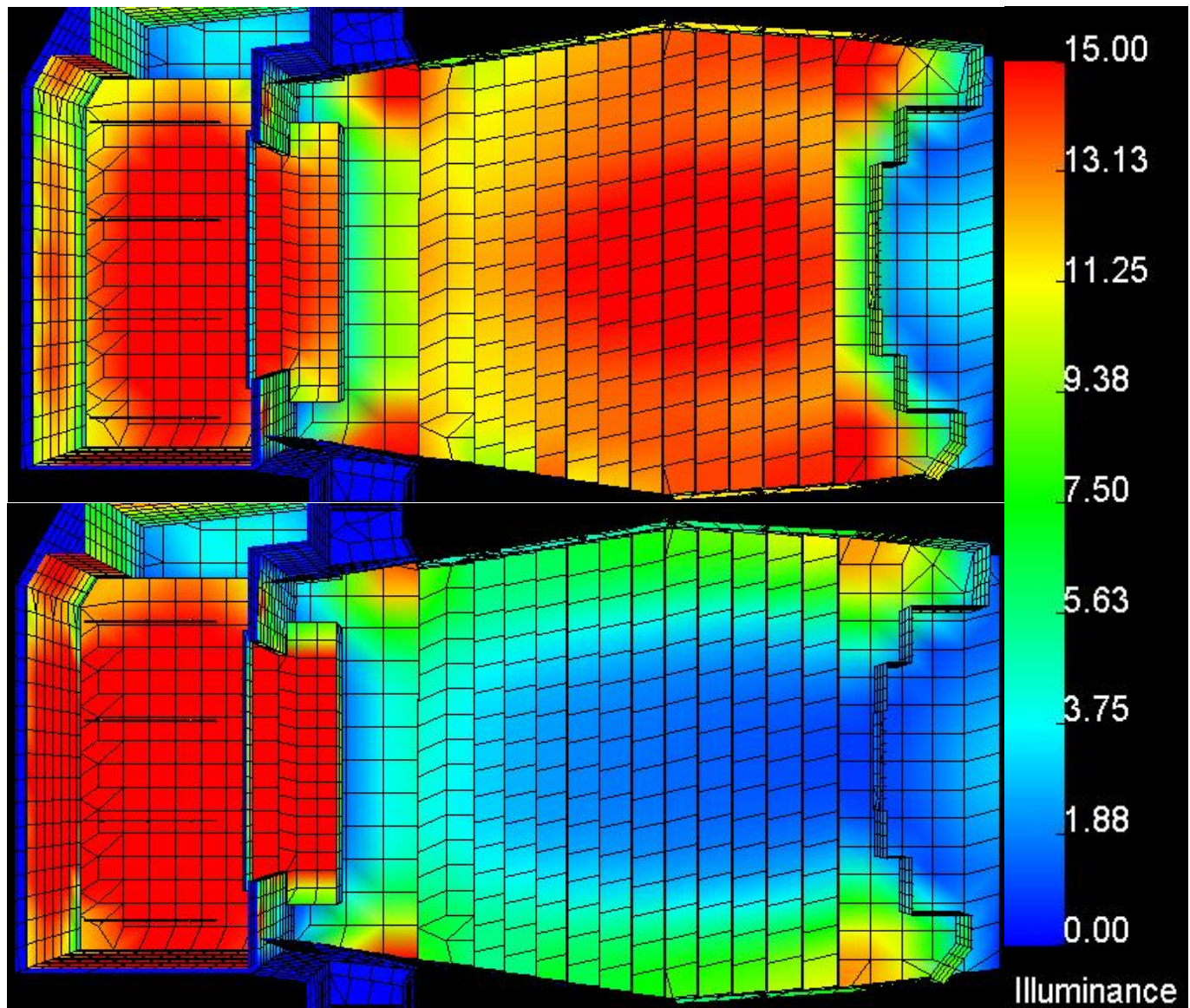
LIGHT LOSS FACTORS						
Type	Lamp Lumens		Light Loss Factors			
	Initial	Mean	LLD	LDD	BF	Total
A2	3000	2850	0.95	0.90	1.20	1.0
B2	3000	2850	0.95	0.90	1.20	1.0
C2	2400	2065	0.86	0.90	1.00	0.8
D2	3000	2850	0.95	0.90	1.20	1.0
EX	-	-	-	-	-	-

Controls

The auditorium is split into multiple zones, all with dimming capabilities. The fixtures in the space that are deemed emergency fixtures are dimmable as well and are fed from a dimming panel connected to the emergency system. These fixtures may be dimmed as desired—in the event of a power outage the control system will force them back to full output. The stage lighting is split into two zones; 4 of the 16 fixtures dedicated to emergency, the rest dimmable, general illumination stage lighting. The recessed downlights located near the entrance and exits of the space, zoned separately, are connected to the emergency system and are set to be always on at full output. The lighting over the general seating area, is split into four zone, with each row of lighting being its own zone. This gives large flexibility in the lighting in the space, allowing the lighting and illuminance levels to be altered depending on the event.

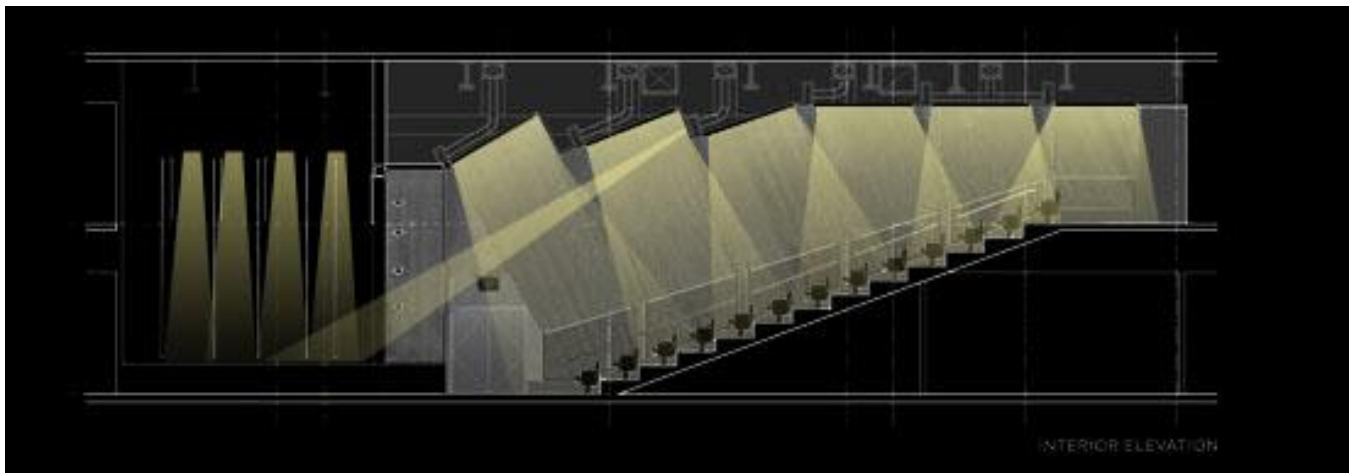
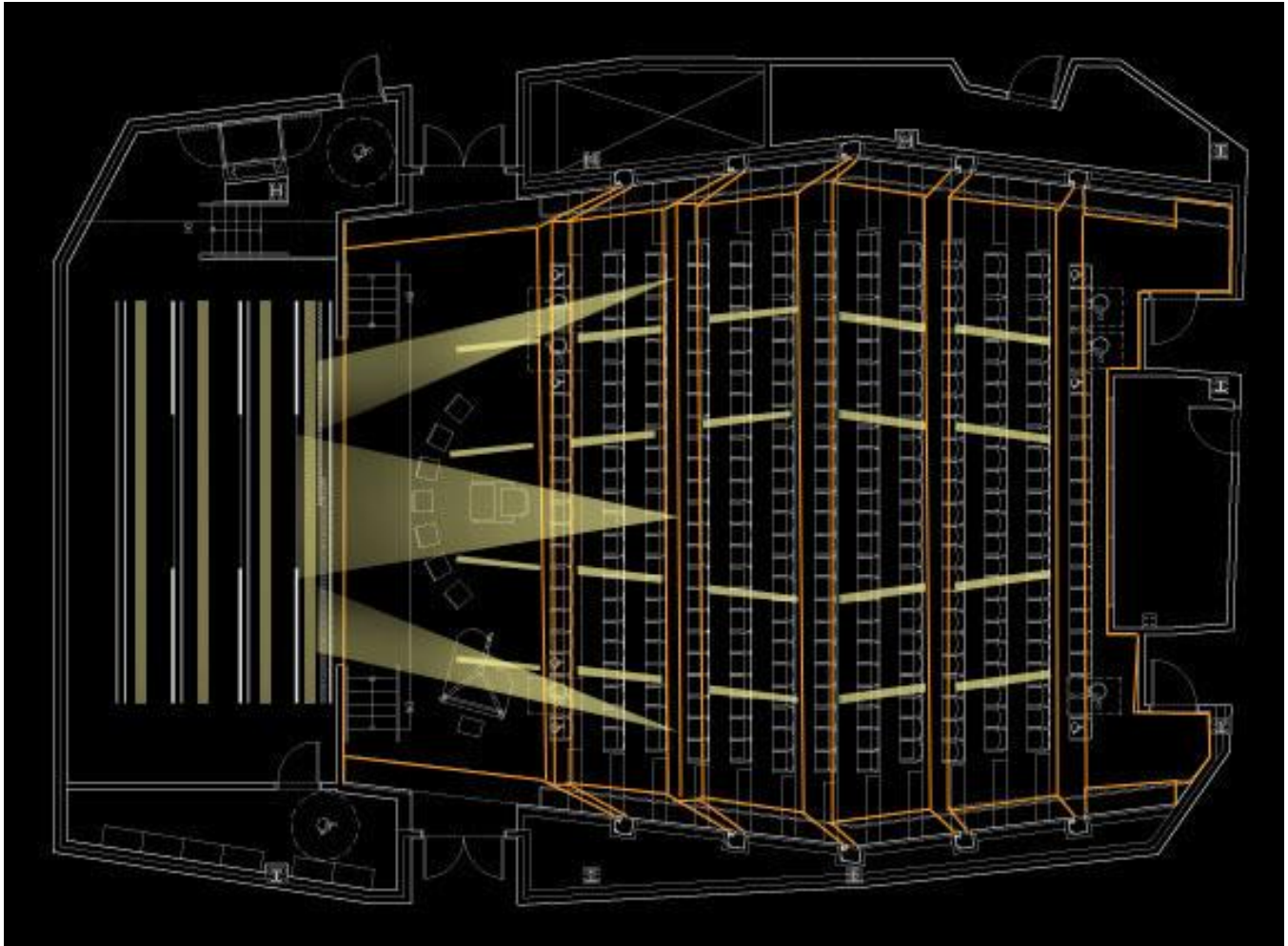
Calculation summary

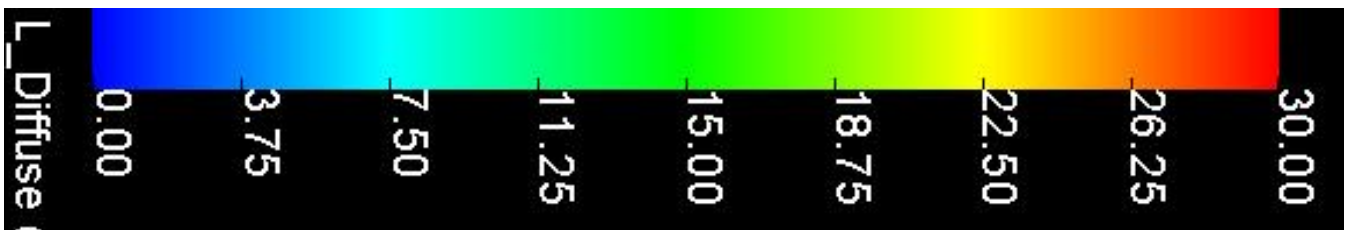
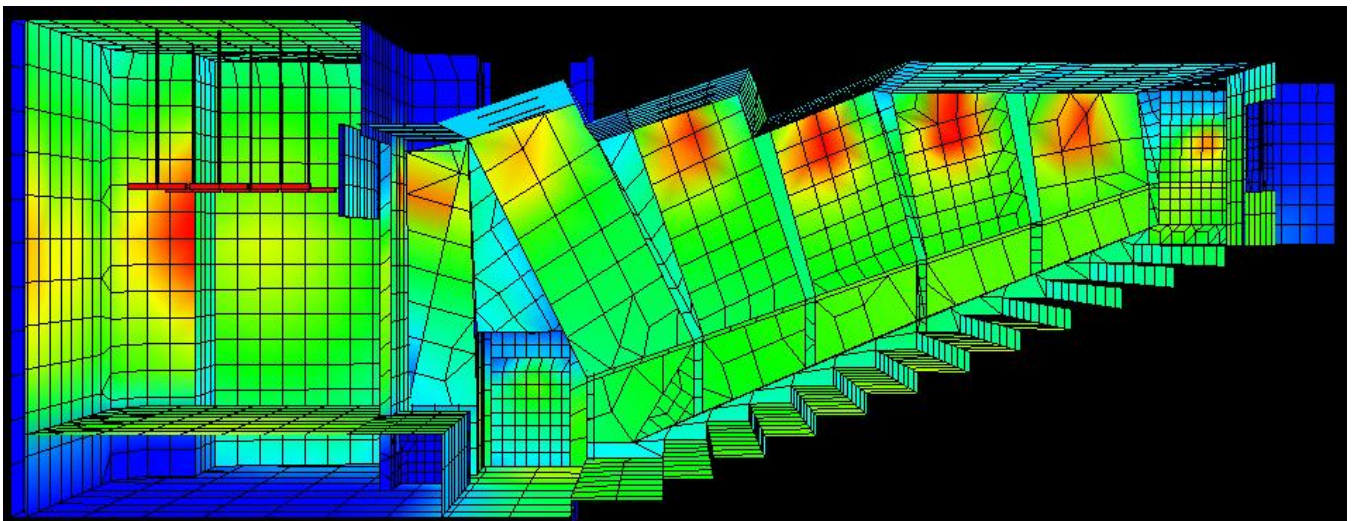
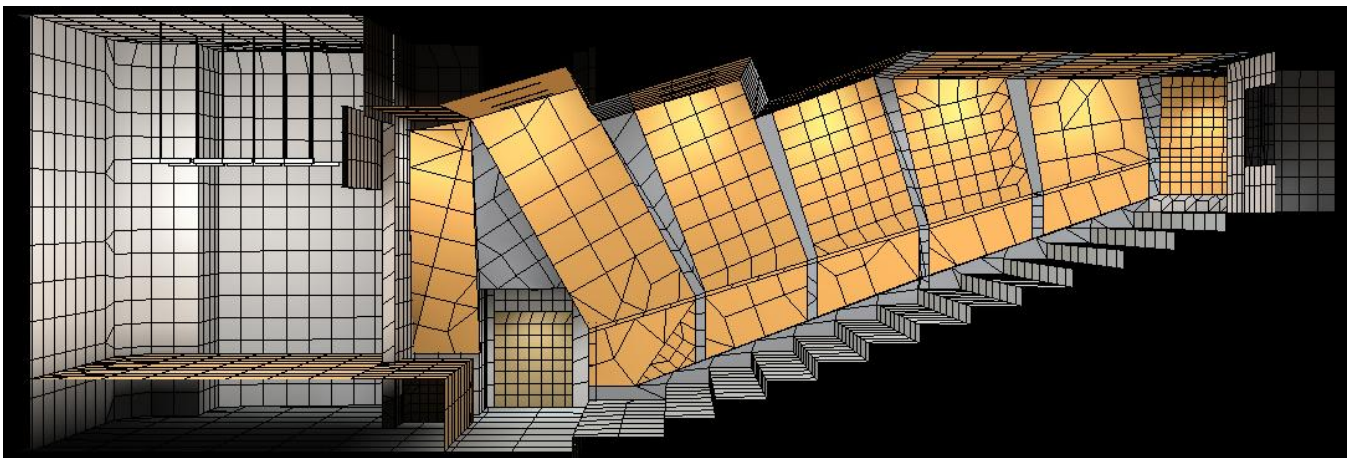
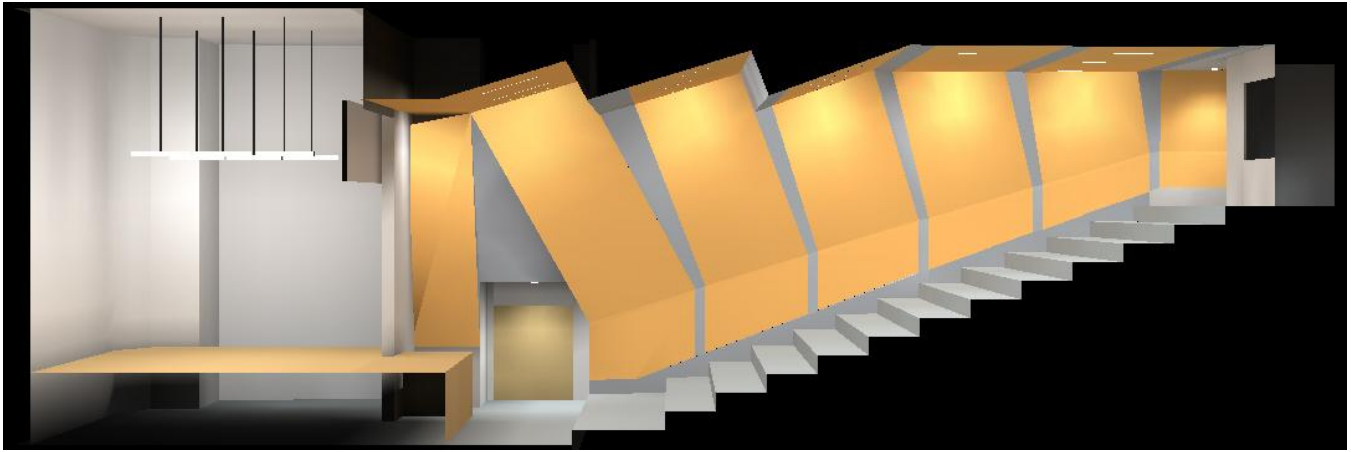
The pseudo diagrams below represent the illuminance distribution in the space under the two lighting scenarios: public and private. The top, the public scenario, has a much more uniform distribution of light throughout the space than does the private scenario. High illuminance levels throughout the space create no particular emphasis at any point, which is desirable for public town meetings or general addresses to the students. The second diagram, the private scenario, has a much less uniform design. The main emphasis is on the stage, with peripheral wall emphasis due to fixtures wall-washing the wood panels

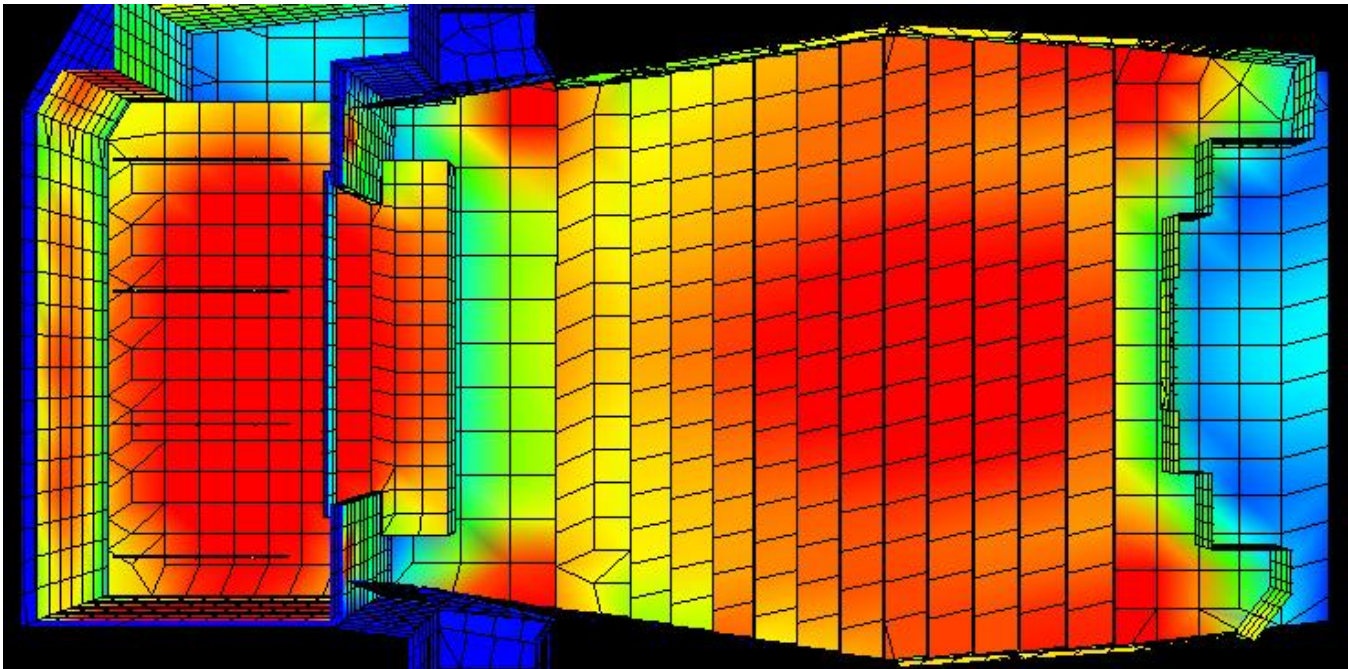
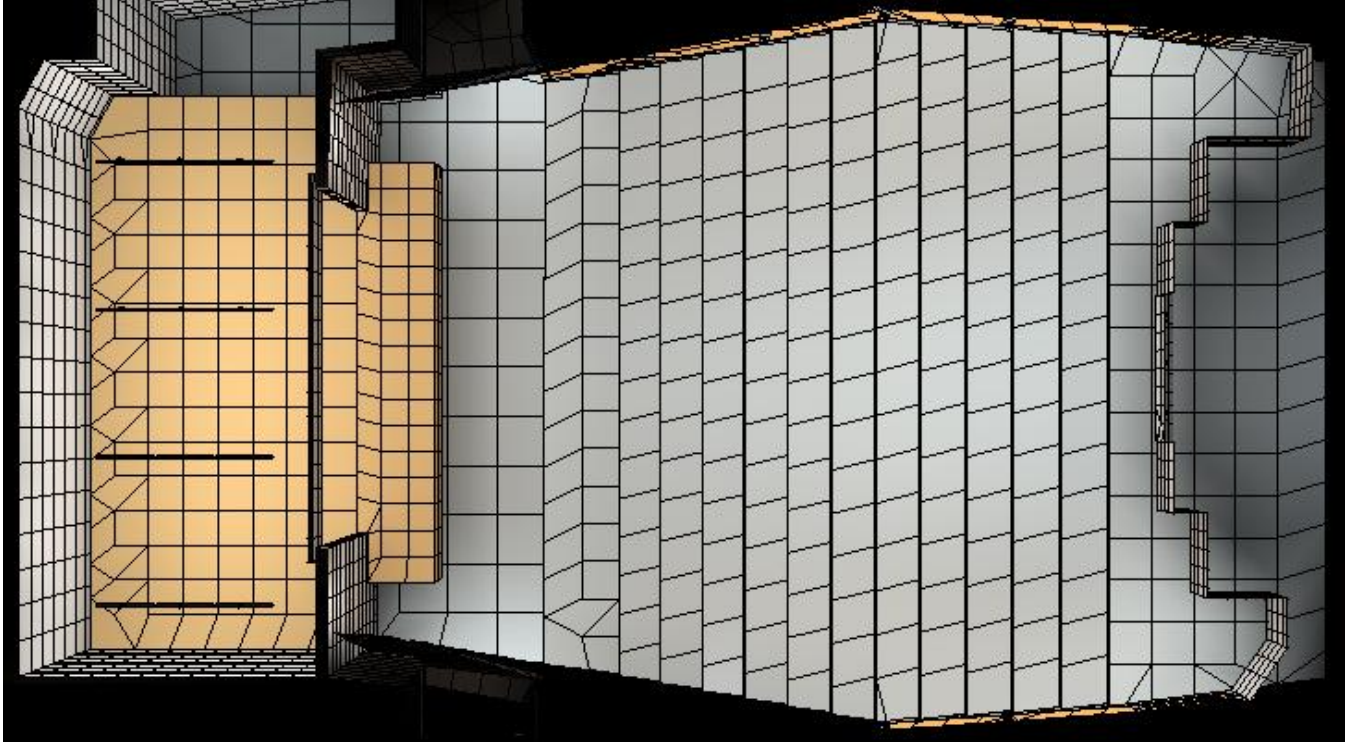


Renderings

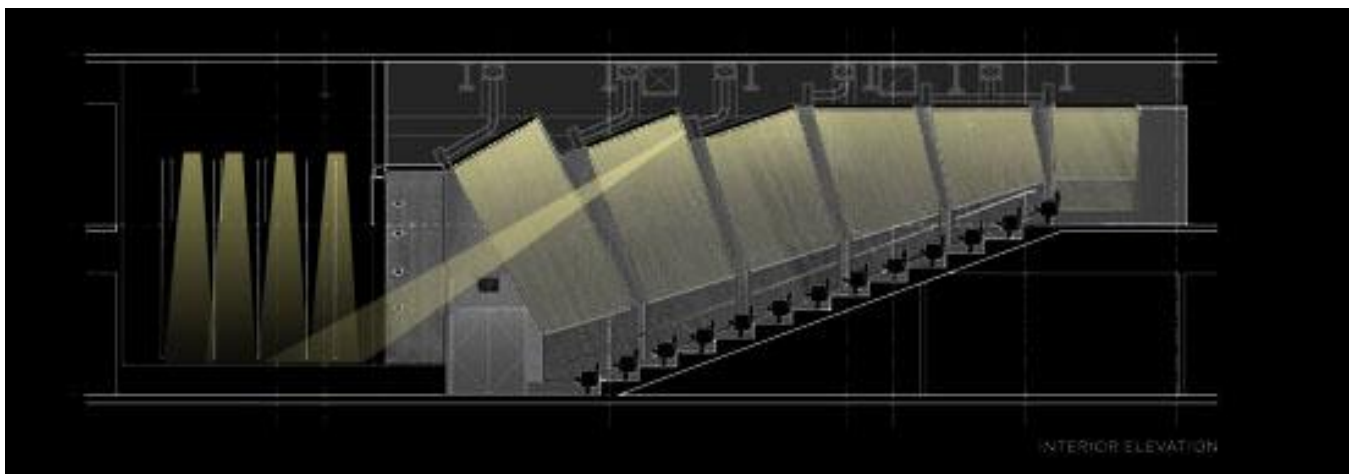
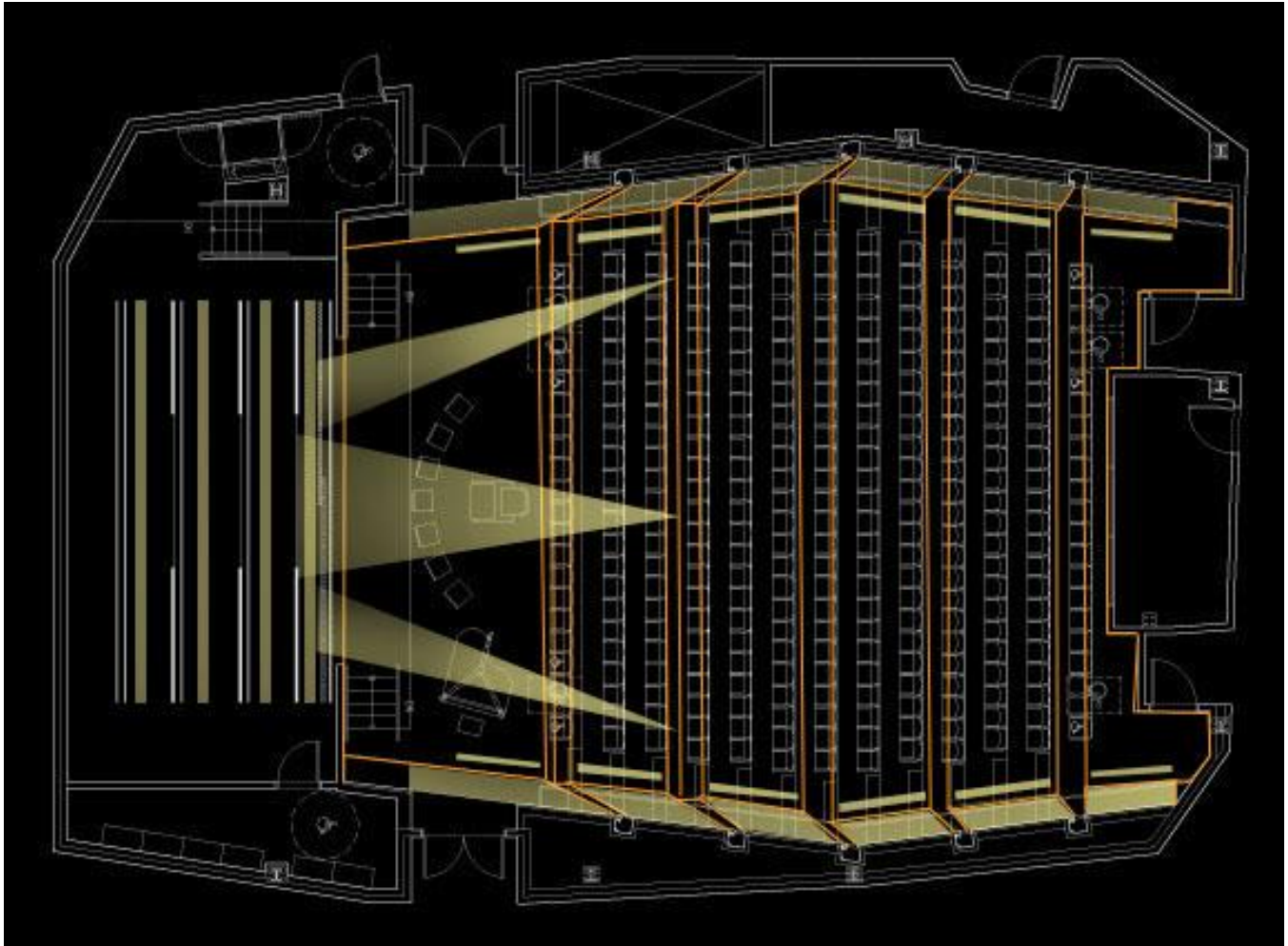
Public

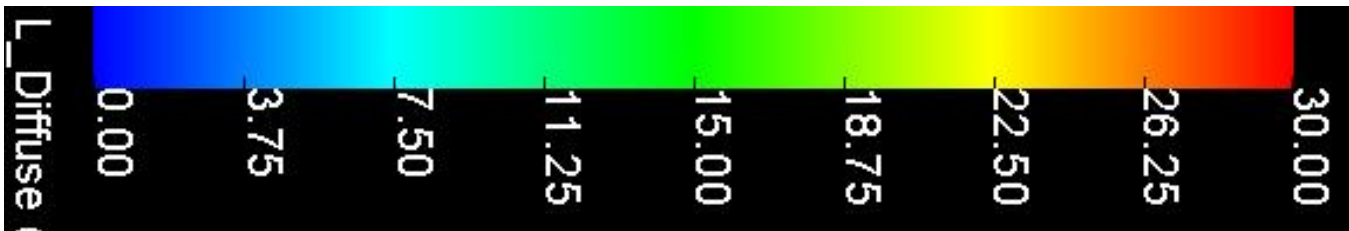
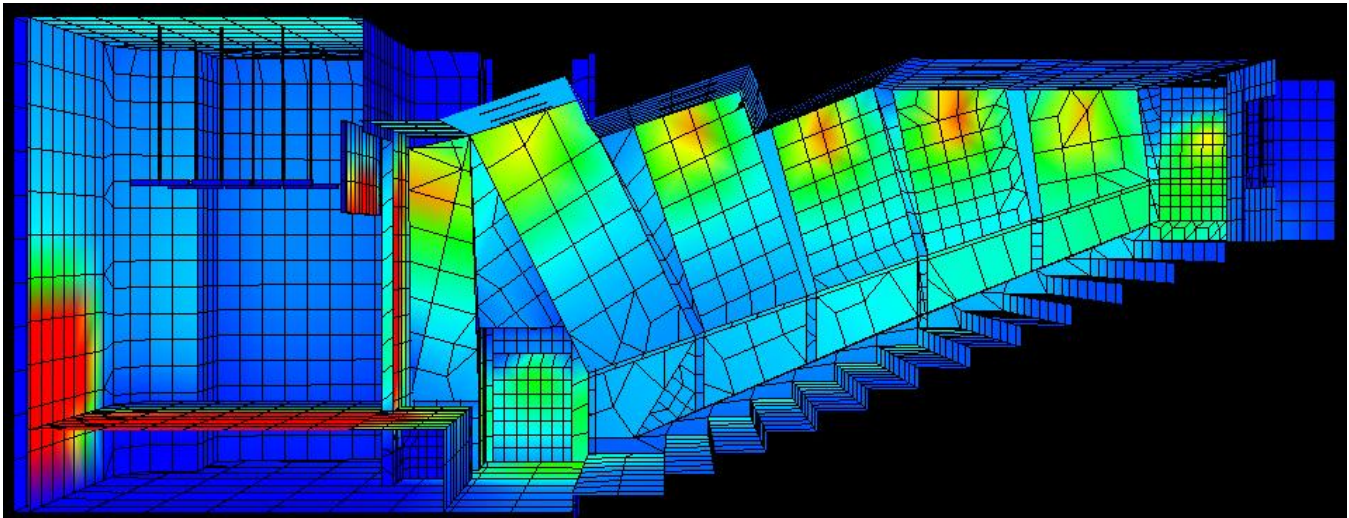
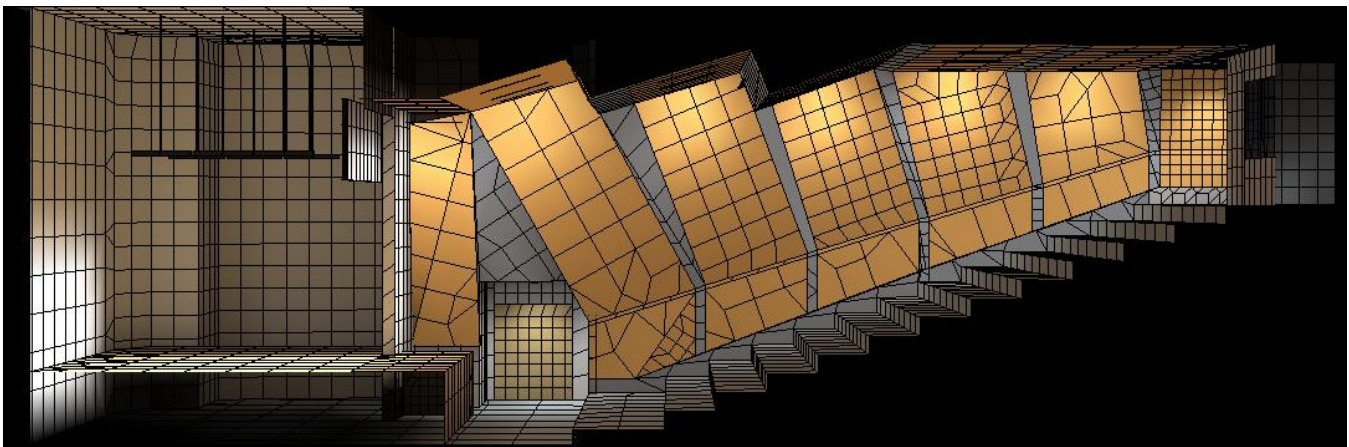
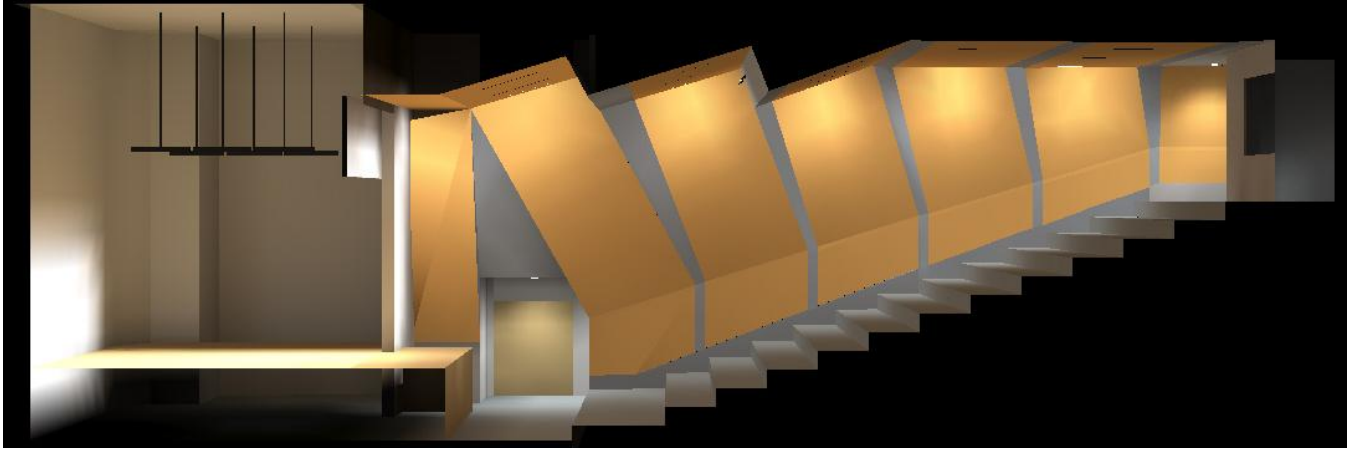


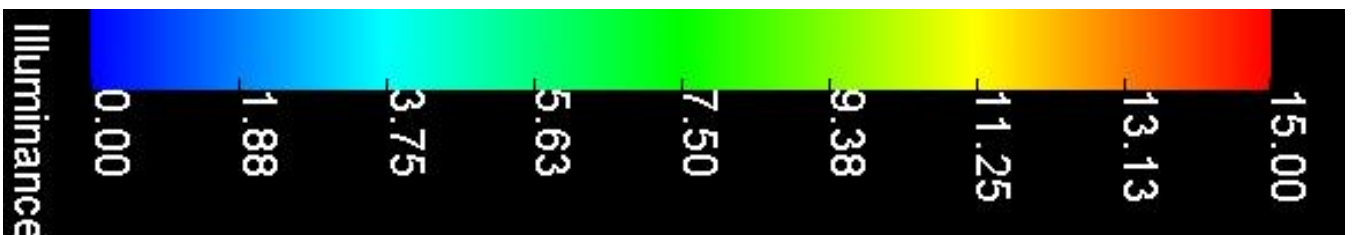
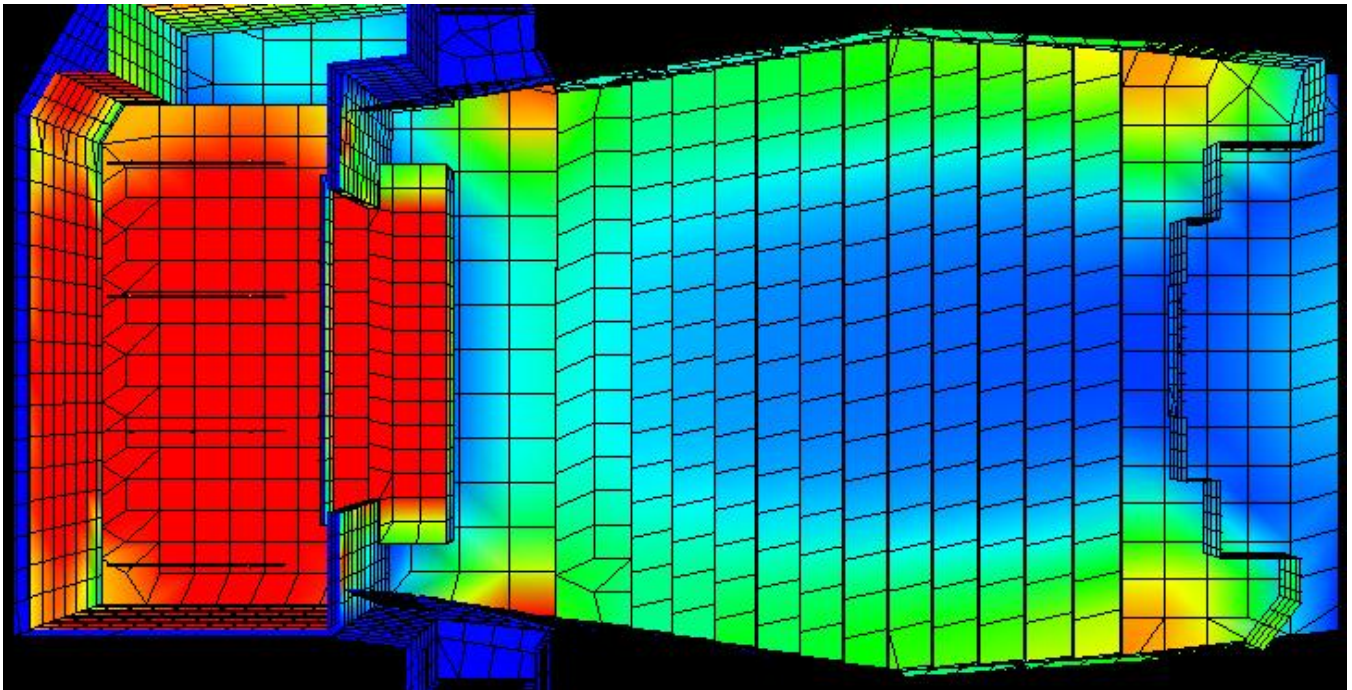
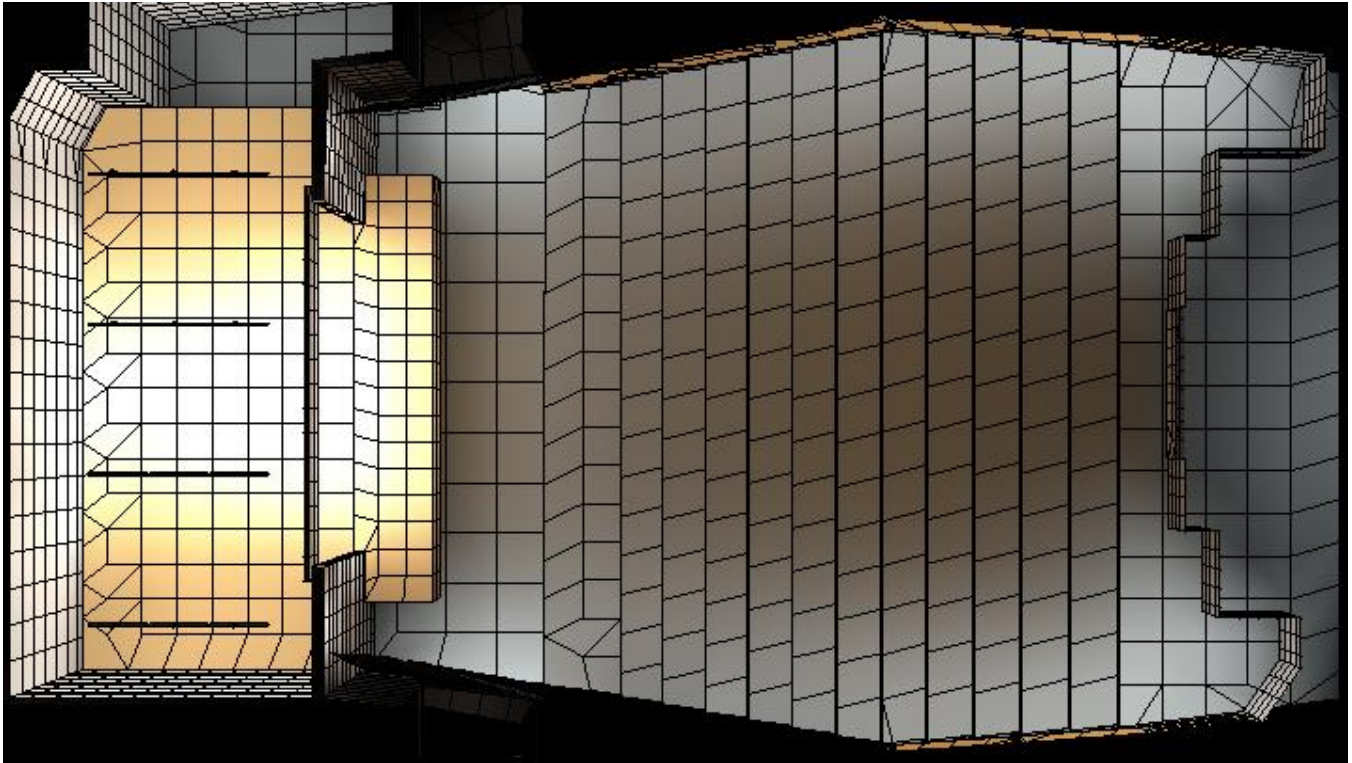




Private







To be, or not to be...



a lighting designer?

Evaluation

Summary

The auditorium lighting design effectively creates public and private scenes via flexible lighting controls. In the private scene recessed linear fluorescent wall washers line the perimeter wall creating large peripheral emphasis. The theatrical spot lights aimed at the stage not highlight the actors, but it also creates a focal point; it creates emphasis distant to the seated audience. The public scenario, which has all luminaire turned on, creates high levels of illumination that are more uniform than that of the private scenario. There is no emphasis on any particular area. The lighting successfully achieves these two opposing Flynn impressions without infringing on the architecture.

ASHRAE/IESNA 90.1

The tables below show the power consumption and ASHRAE/IESNA 90.1 code requirements for the Intermediate school cafeteria. The space consumed a total of 1,993 watts which is lower than the calculated allowable 2,907 watts. At this power consumption, the space has a total power density of 0.54 watts/ft², which is lower than the 0.79 allotted by ASHRAE. Please note that because the theatrical lighting was not part of my scope of design, it has not been included in either the illuminance (with the exception of the stage spotlight) or the power density.

Auditorium ASHRAE/IESNA 90.1		
Category	Allowable	Actual
Area (sq.ft.)	-	3680
Input Watts (W)	2907.2	1993
Power Density (W/ft)	0.79	0.54

AUDITORIUM TOTAL INPUT WATTS				
Type	Lamp	Qty	Input W	Total W
A2	(1) F32T8	20	38	760
B2	(1) F32T8	12	38	456
C2	(1) 32CFTR	4	36	144
D2	(1) F32T8	16	38	608
EX	LED	5	5	25
			Total:	1993

3 | Intermediate School Cafeteria

This section, dedicated to the documentation of the lighting design solution for the Intermediate School cafeteria, contains all information pertinent to fully describing the space and lighting design. Included are the design goals and criteria, utilized fixtures and equipment schedules, control descriptions with appropriate diagrams, calculation summary as quantitative evaluation of the design, renderings of appropriate views, and an evaluation comparing the design solution against the design goals set at the outset of the design. This section is outlined as follows:

Description

Space Location

Finishes

Furnishings

Tasks/Activities

Overall Design Goals

Design Criteria/Considerations

Illumination Recommendations

Design Considerations

Daylighting

June 21 – Overcast Sky – Noon

June 21 – Clear Sky – Noon

March 21 – Clear Sky – Noon

December 21 – Clear Sky – Noon

Fixtures and Equipment

Controls

Calculation summary

Electric Light Only

Electric Light and Daylight

Renderings

Electric Light Only

Electric Light and Daylight

Evaluation

Summary

ASHRAE/IESNA 90.1

Description

Area: 2115 ft²

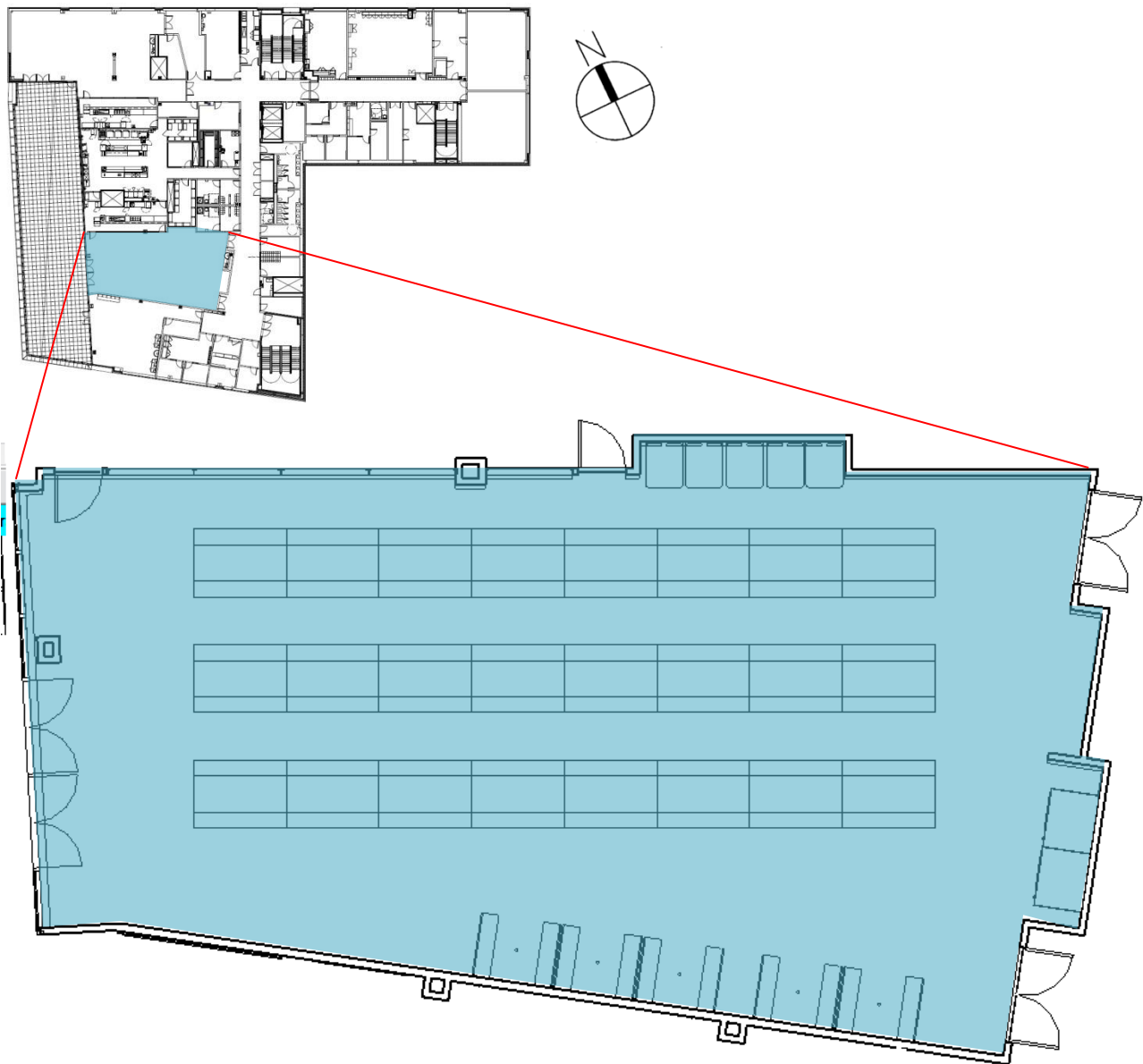
Length: 73 ft.

Width: 40 ft.

Ceiling Height: 10 ft (table eating area), 7 ft (bench eating area)

Location (in building)

The Intermediate School (IS) cafeteria is located on the 5th floor directly (plan) north of the High School (HS) Art Room. There is no direct circulation between these two rooms, but like the High School Art room, the cafeteria has direct access to the exterior roof terrace. The two doors, located on the western side of the North wall, lead to the lunch line, which is linked directly to the kitchen.



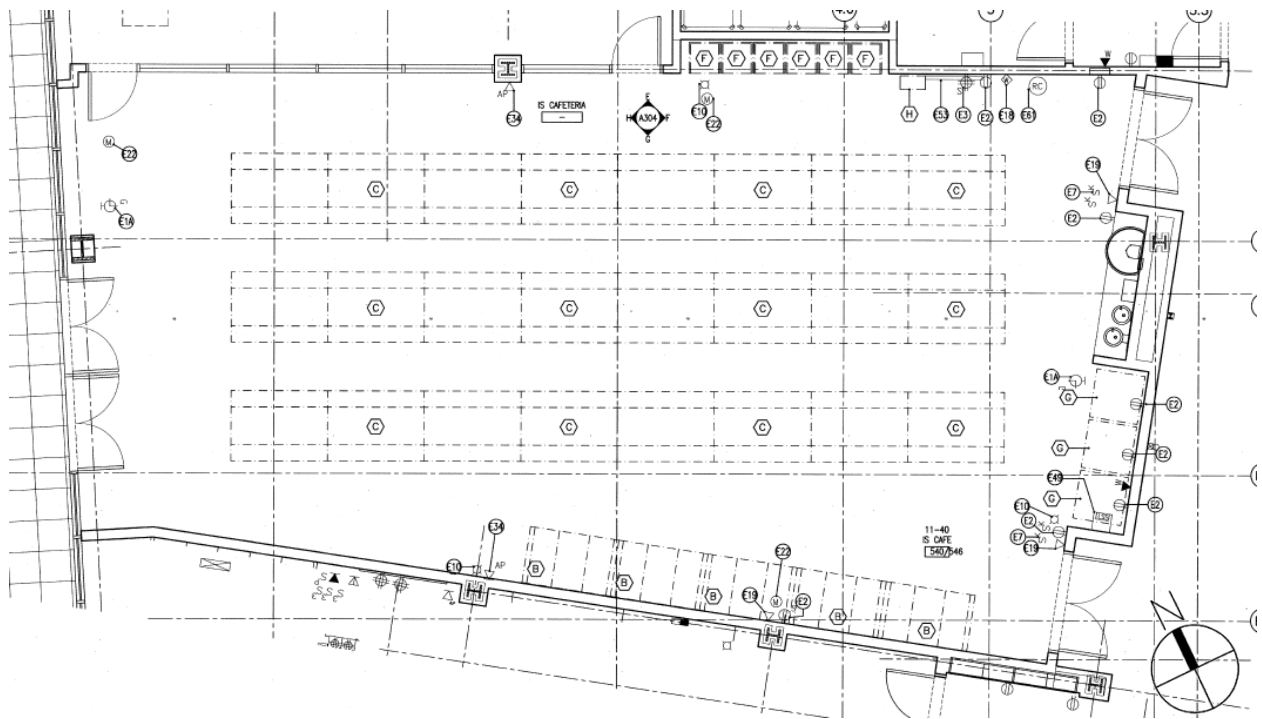
Finishes

The floor of the IS Cafeteria is a pewter vinyl composite tile. The walls, which are a semi-gloss white paint, aid in the distribution of light throughout the space. Also on the walls, are matte white tiles, semi-gloss white tiles, and a tri-color blend of mosaic tiles. These mosaic tiles may be arranged in any configuration desirable, and can be used as a tool to achieve a desired feeling in the space.

IS Cafeteria Materials				
Surface	Material	Description	Style/Color	Reflectance
Floor	VcT	12" x 12" Vinyl Composition tile	112 Pewter	0.30
Walls	SG-P	Semi-Gloss Paint	Simply White OC-117	0.85
Wall Panels	GCT - 1	Glazed Ceramic Trim Tile	Artic White - Matte	0.85
	GCT - 2	Glazed Ceramic Trim Tile	Artic White - Semi-Gloss	0.85
	GCT - 5	2"x2" Glazed Ceramic Mosaic Tile	1:1:1 Three color Blend	0.70
Ceiling	GWB	Gypsum Wall Board Painted White	White	0.75

Furnishings

In the main eating area of the cafeteria there are 24 cafeteria tables with benches. The East wall contains 3 vending machines, while the recessed portion of the north wall contains six trash cans. The south wall contains additional seating with booths on the wall.



Tasks/activities

The primary task in this space is eating (more specifically – lunch). Light levels should be adequate enough that eating is not difficult. One additional consideration for this space is security. Lunch rooms in schools may lend themselves to behavioral problems especially in a large, culturally diverse area such as Queens, New York.

Overall design goals

The intermediate school cafeteria is attached indirectly to the HS cafeteria and HS art room via the outdoor roof terrace. This space was chosen to achieve my overall design goal of connectivity of **people + program**, as it was the original design goal of the architect to physically connect the IS and HS cafeterias. My design goals for the space are represented by the pictures below:

| Reflective of Space Usage



| Suitable Eating Illuminance



| Fun + Creative



Fun and creative: the main occupants of this space will be middle school students, and as such, the design should be fun and interesting to look at. It's very easy for this space to fall victim to a standard, boring lighting design, which is my goal to avoid.

Reflective of space usage: when you walk in the doors to the cafeteria, it should be immediately evident that this space is used for eating purposes.

Provide illuminance suitable for eating: as this space is a cafeteria, the main task in the space is eating. The lighting in the space should provide suitable illuminance for eating purposes.

Design Criteria/Considerations

Illuminance recommendations

Horizontal Illuminance – Important

- IES Classification: Common Applications – Food Service – Cafeterias
 - Category N: 75 lux (7.5 fc)
 - Avg/Min: 3:1

Horizontal illuminance in this space is *important* because there needs to be adequate light for the students to eat, and is not a critical task. As long as the luminaires in the room are maintained, there should be no problems achieving adequate illumination levels.

Vertical Illuminance – Very Important

- IES Classification: Common Applications – Food Service – Cafeterias
 - Category K: 25 lux (2.5 fc)
 - Avg/Min: 3:1

As the cafeteria could be a source of mischievous behavior, vertical illuminance is essential for face recognition. The adequate illumination for facial recognition of the students is essential for both the school faculty and the security system (cameras).

Design Considerations

Appearance of Space and Luminaires – Somewhat Important

The main task in this space is eating, which for the purpose of a middle school cafeteria is not an aesthetically demanding experience. The emphasis tends to be on getting the students in, fed, and out of the space quickly and smoothly. However, the lack of typicality with these types of spaces should not deter from a good lighting design. Although not critical to the space function, the appearance of the space and luminaires should be carefully considered to achieve a quality lighting design solution.

Color Appearance and Color Contrast – Very Important

School cafeteria food typically has problems with appearance and quality – the lighting solution should be conscious of this and be designed to optimize color. The chosen light source should have high CRI, with minimal to no color shift over the life of the source. Acceptable light sources might include fluorescent (linear and compact), metal halide, and induction. Unacceptable sources may include high pressure sodium, and some LED's (depending on the quality, trustworthiness, and dependability of the manufacturer).

Daylighting Integration and Controls – Important

The west wall of the space—which happens to be the smallest in the room—has floor to ceiling glazing. Although the percent of wall area of glazing in the space is low, and the (only) wall with glazing is facing west, daylight penetration should still be considered in the design. Cost analyses may be performed to determine the feasibility of photosensor dimming, with payback period being the main criteria for determination of system feasibility and practicality.

Direct and Reflected Glare – *Somewhat Important*

Glare itself is an important design consideration and should be avoided whenever possible. However, there is no added importance of glare in this space than normal. That is, there are no critical tasks in this space that require additional attention to glare.

Flicker – *Somewhat Important*

Flicker itself is an important design consideration and should be avoided whenever possible. However, there is no added importance of flicker in this space than normal. That is, there are no critical tasks in this space that require additional attention to flicker.

Light Distribution on Task Plane – *Somewhat Important*

Uniformity on the eating surface is important in that there needs to be sufficient illuminance to eat. This holds true for uniformity as well. Illuminance and uniformity levels should meet the recommended levels. There are no special light distribution criteria to be considered.

Modeling of Faces or Objects – *Important*

Public school cafeterias tend to be areas of high horseplay especially when intended for younger students. With these security concerns, monitoring staff should be able to easily identify a student if need be.

Shadows – *Somewhat Important*

A uniform lighting solution is desired in this space, but high uniformity can make the space feel boring and flat. Surfaces lit non-uniformly create reliefs in the visual field of the eye. However, lighting should not be so non-uniform that shadows are distracting and uncomfortable. Shadows are important to avoid, but not so much that it requires additional attention.

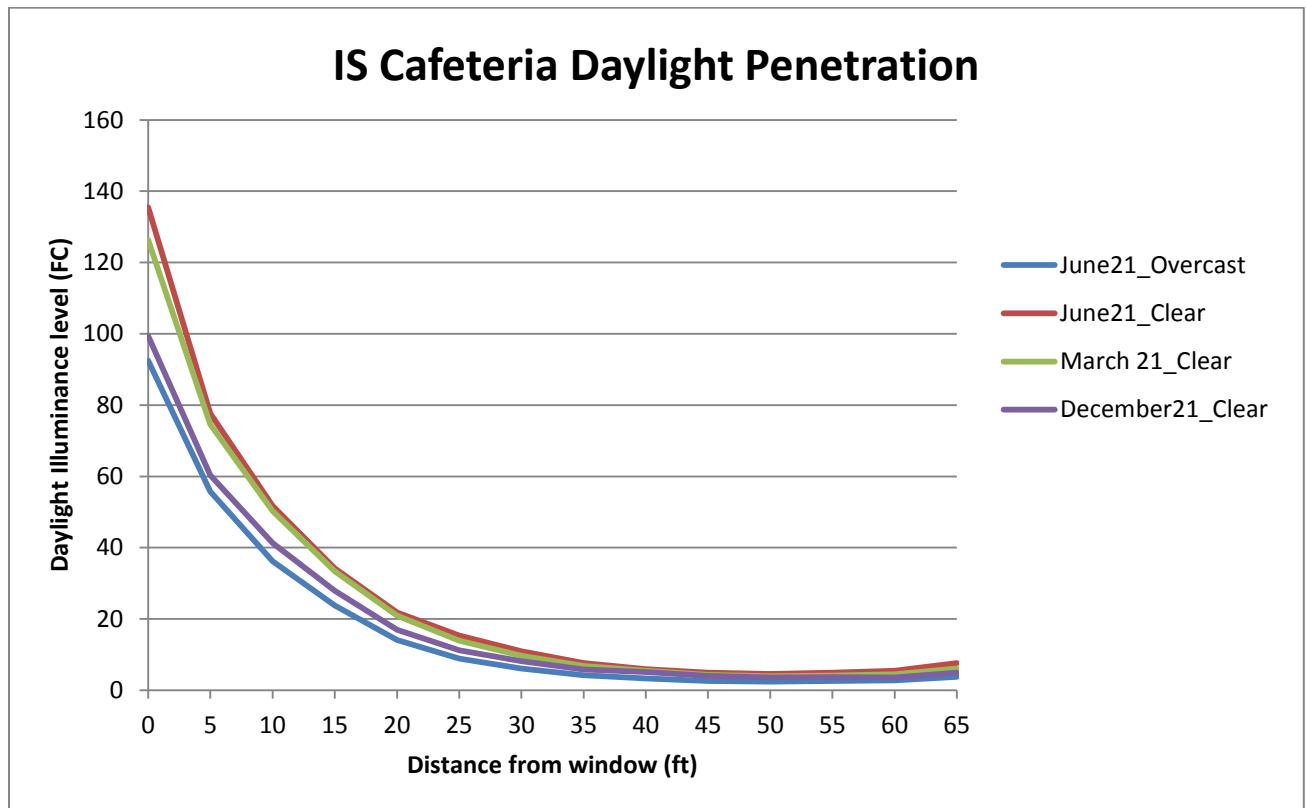
Special Considerations –*Very Important*

Because this is a public school building and this space will primarily contain middle school students, there are inherent security issues that have to be addressed. Lighting control devices such as switches and touchpads must be either out-of-reach of the students, or have restricted access by key or code.

Daylighting

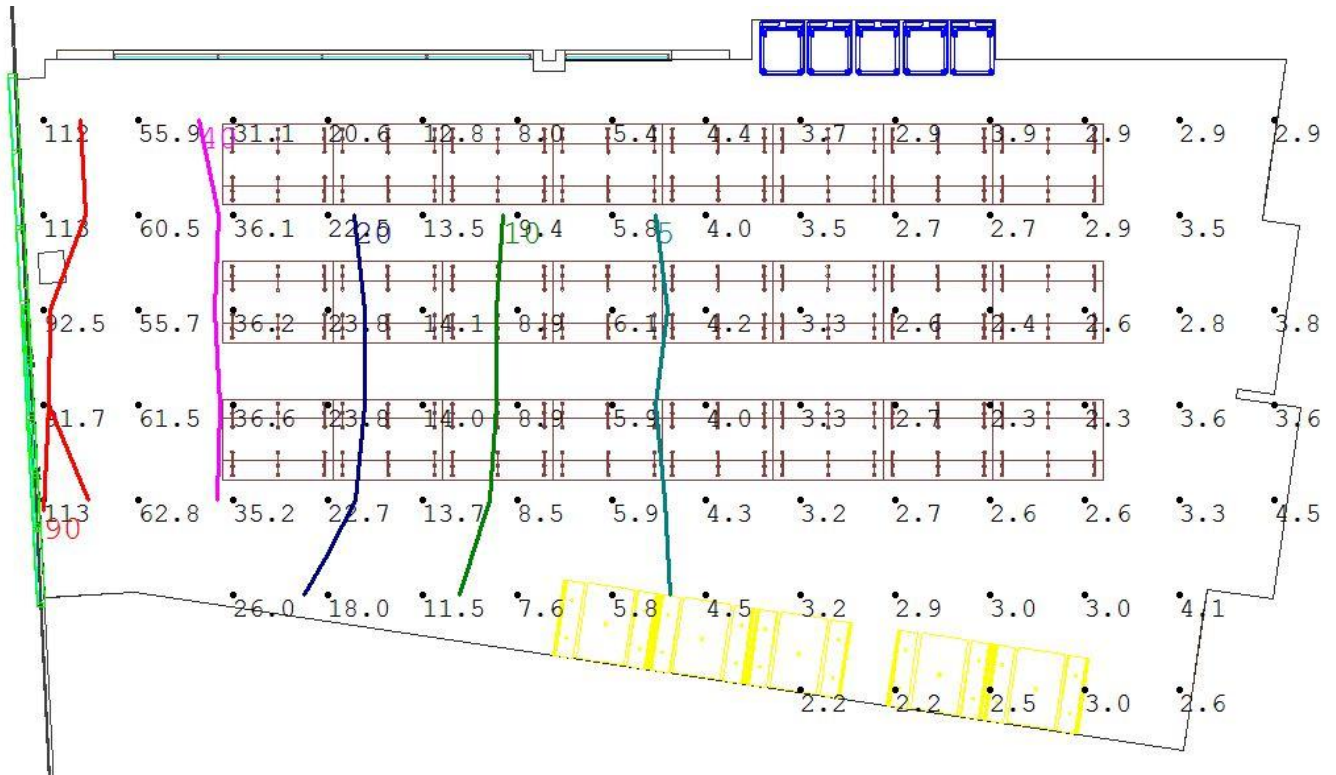
An approximate daylighting analysis was performed on this space to get a general idea of the available daylight illuminance in the space. This space is not the subject of my M.A.E. daylighting breadth. This analysis is an extra effort to have a full understanding of the factors that may affect the lighting design in this space.

Below is a graph of the daylight penetration (Daylight illuminance of the space as a function of distance from the window) for the Intermediate School Cafeteria. This graph includes multiple times of year (Spring, Summer, Winter) and two sky conditions (Clear, Overcast). The shape of the graph is as expected – the daylight illuminance decreases as the distance from the window increases. An interesting find is that the daylight illuminance values fluctuate very little over the different times of year and sky conditions. Although it would be expected that the overcast sky would produce a lower illuminance level overall – and is confirmed in the below graph – we can see that it does not vary significantly. This is most likely due to the orientation of the space, which has the glazing facing predominantly north.



The illuminance results for the space under four daylighting conditions are presented on the following pages. These conditions (all conducted at Noon) are as follows: June 21st with an overcast sky, and June 21st, March 21st, and December 21st with a clear sky. The results on the following page include an isoline diagram showing daylight penetration as well as renderings and luminance pseudo diagrams (with and without meshing).

June 21 – Overcast Sky – Noon

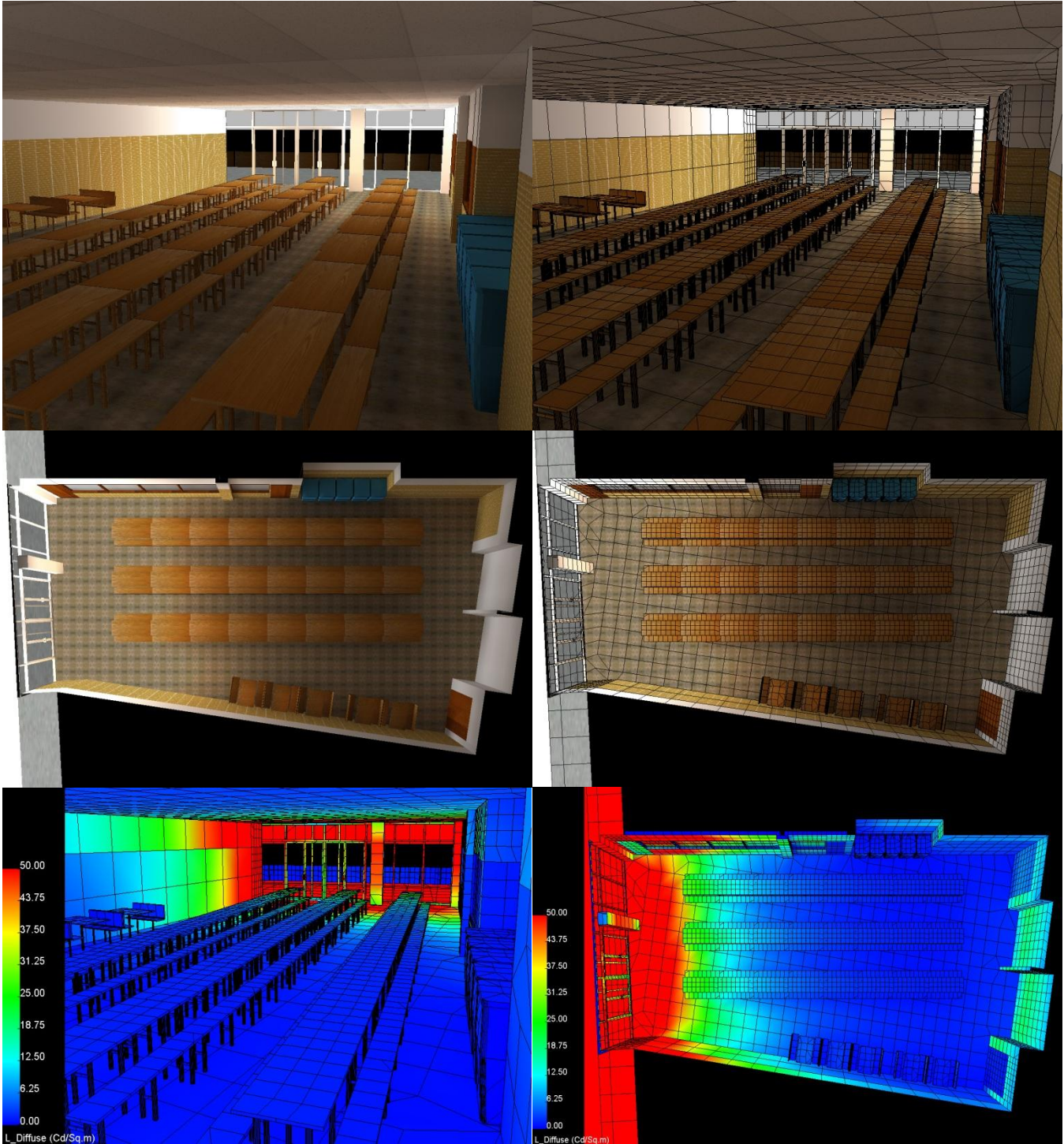


Statistics

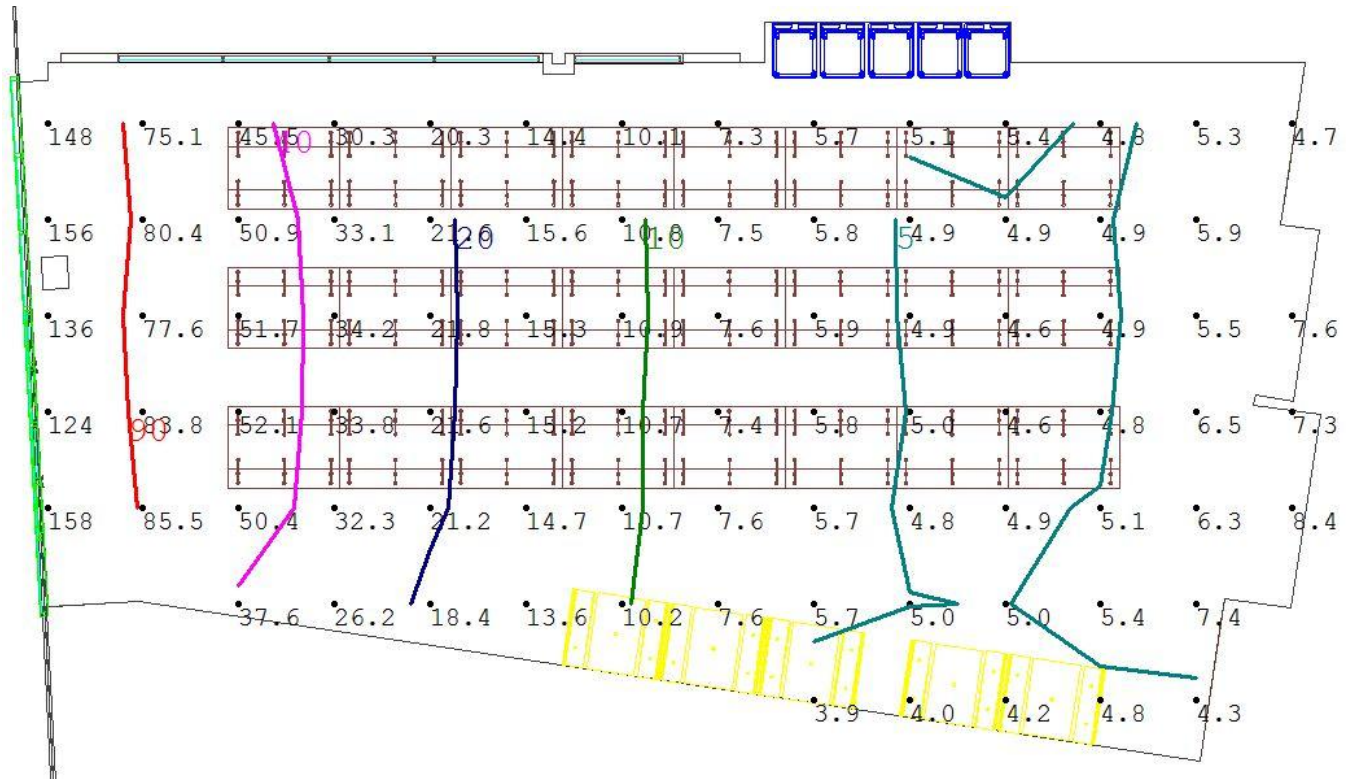
Project 1
Calc Pts

floor
 Illuminance (Fc)
 Average=17.17 Maximum=113
 Minimum=2.2 Avg/Min=7.80 Max/Min=51.45

Value (Fc)	Color	Value (Fc)	Color
90	Red	5	Teal
40	Magenta		Dark Red
20	Blue		Purple
10	Green		Olive



June 21 – Clear Sky – Noon



Statistics

Project 1

Calc Pts

floor

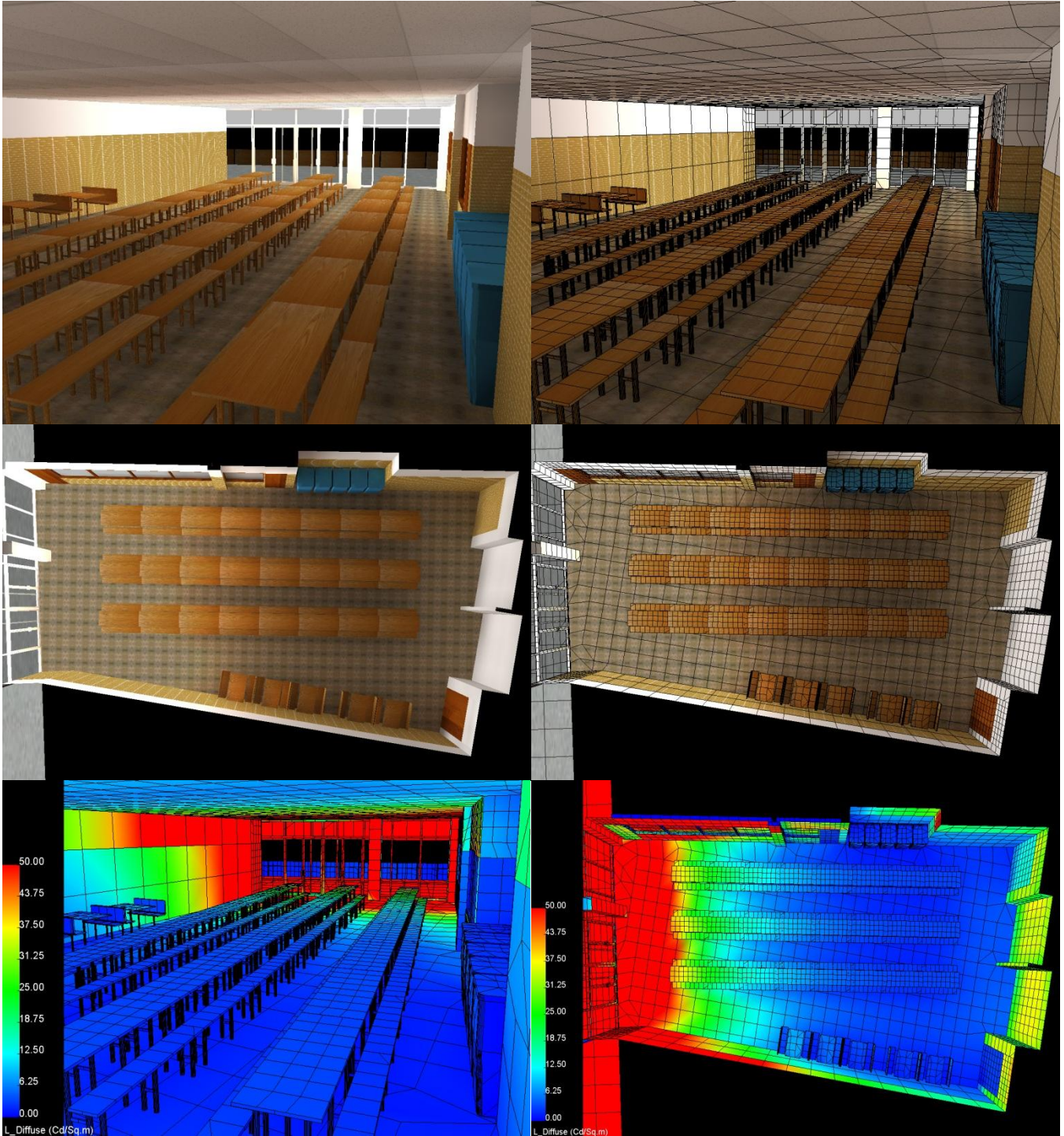
Illuminance (Fc)

Average=25.11 Maximum=158

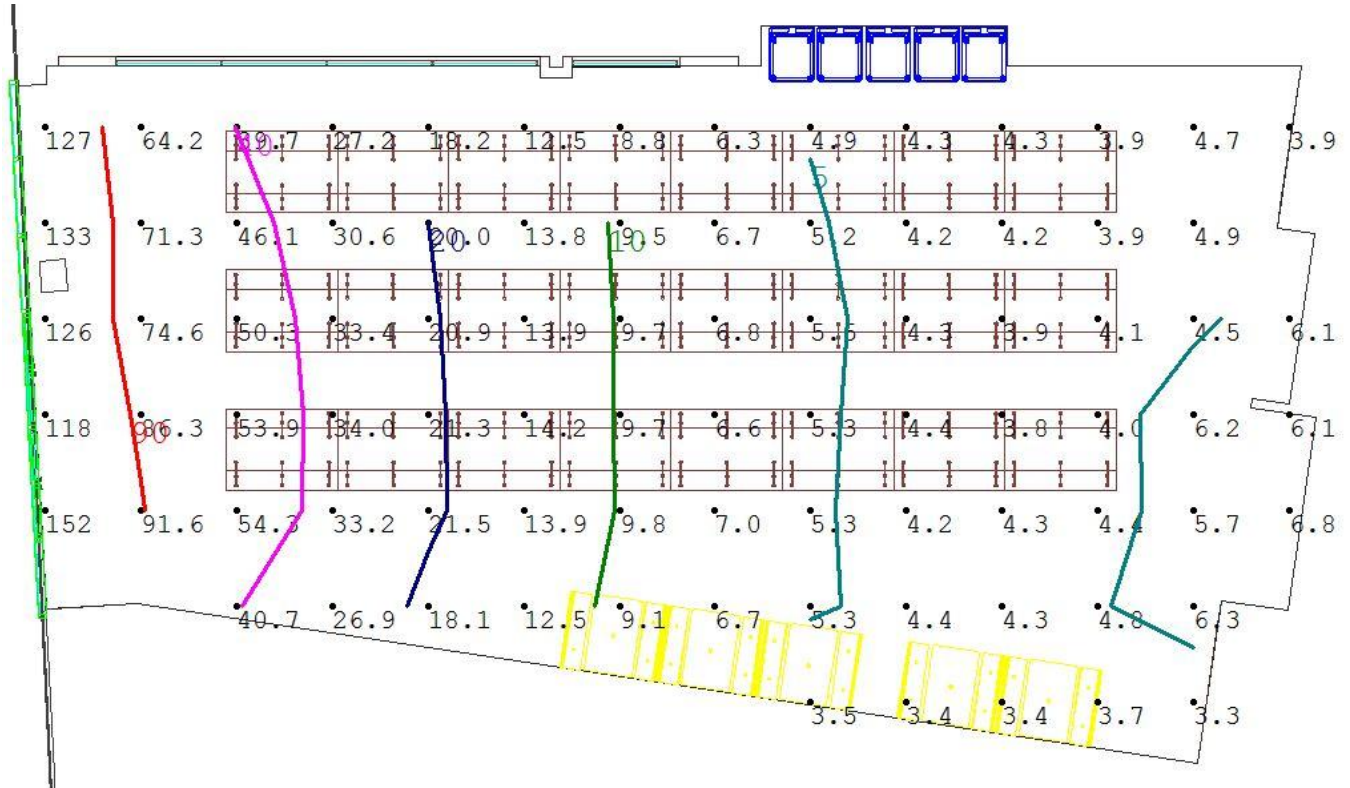
Minimum=3.9 Avg/Min=6.44

Max/Min=40.64

Value (Fc)	Color	Value (Fc)	Color
90	Red	5	Teal
40	Magenta		Brown
20	Blue		Purple
10	Green		Olive



March 21 – Clear Sky – Noon

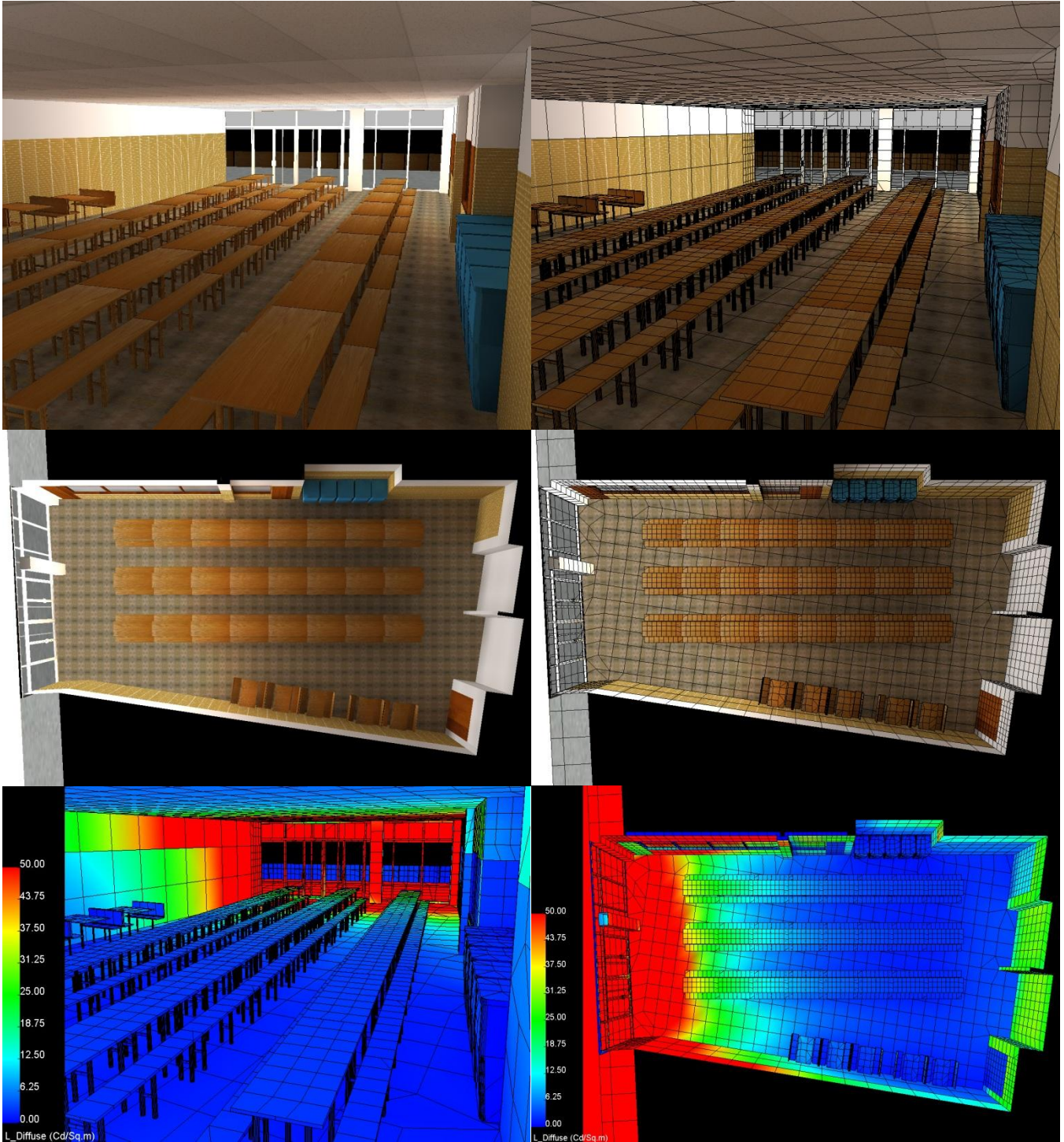


Statistics

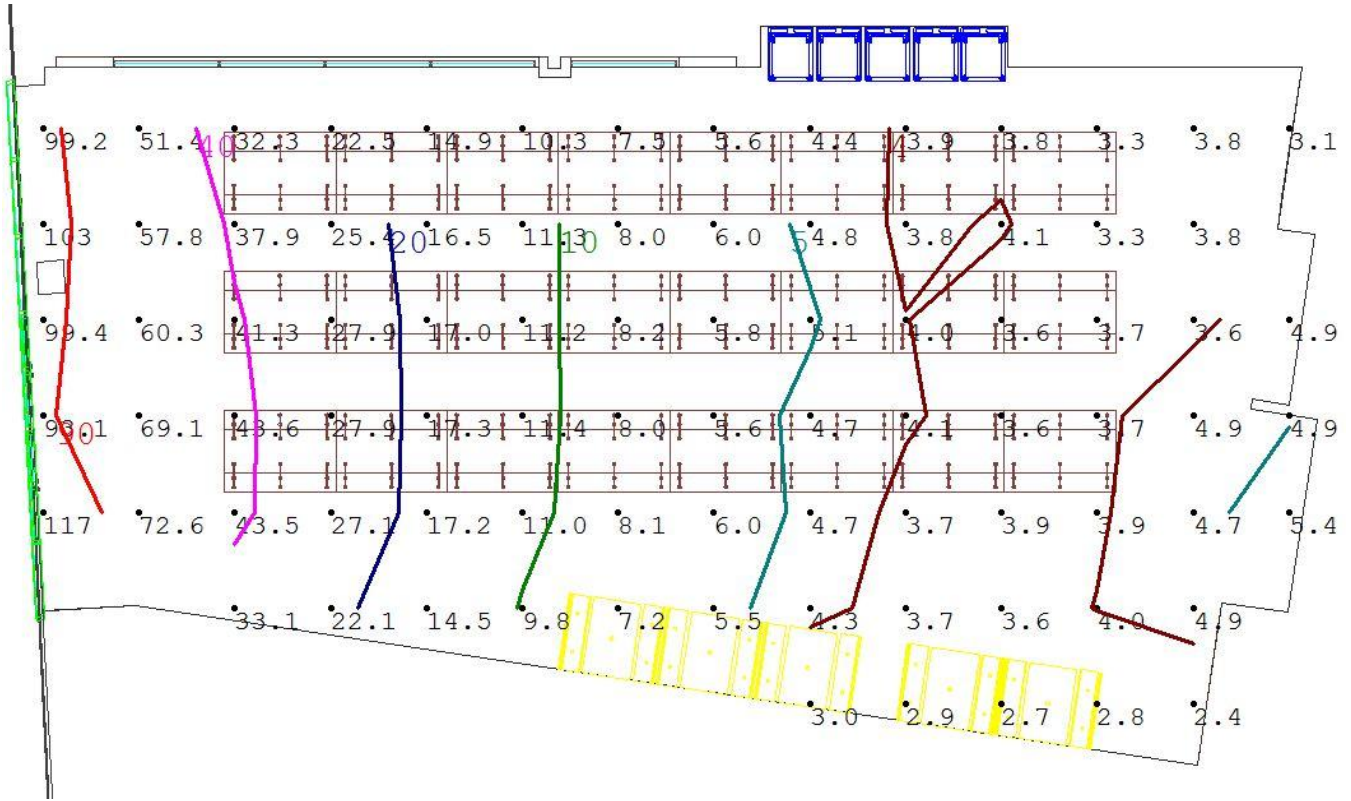
Project 1
Calc Pts

floor
 Illuminance (Fc)
 Average=23.44 Maximum=152
 Minimum=3.3 Avg/Min=7.10 Max/Min=46.15

Value (Fc)	Color	Value (Fc)	Color
90	Red	5	Teal
40	Magenta		Dark Red
20	Blue		Purple
10	Green		Olive



December 21 – Clear Sky – Noon



Statistics

Project 1

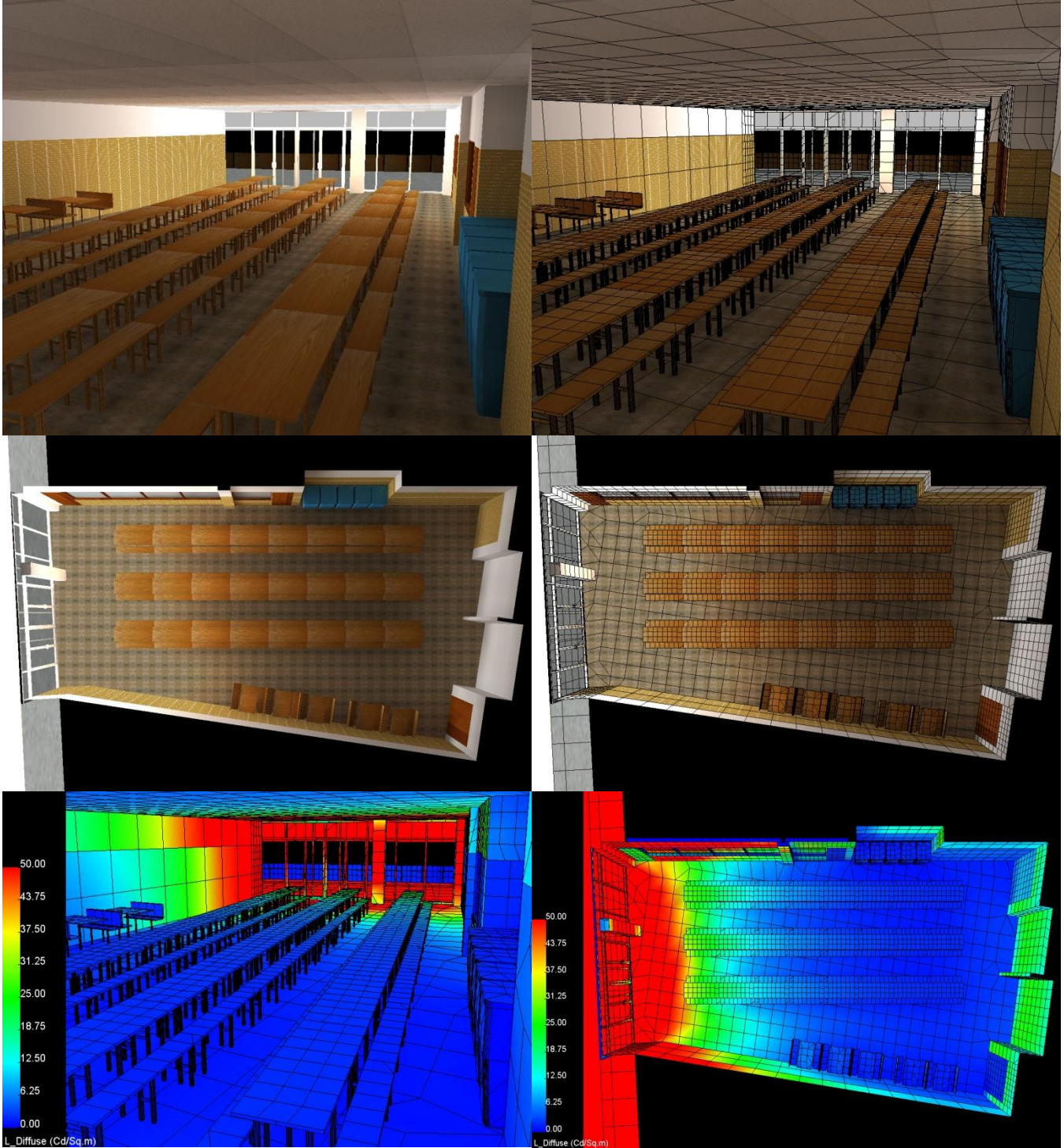
Calc Pts

floor

Illuminance (Fc)

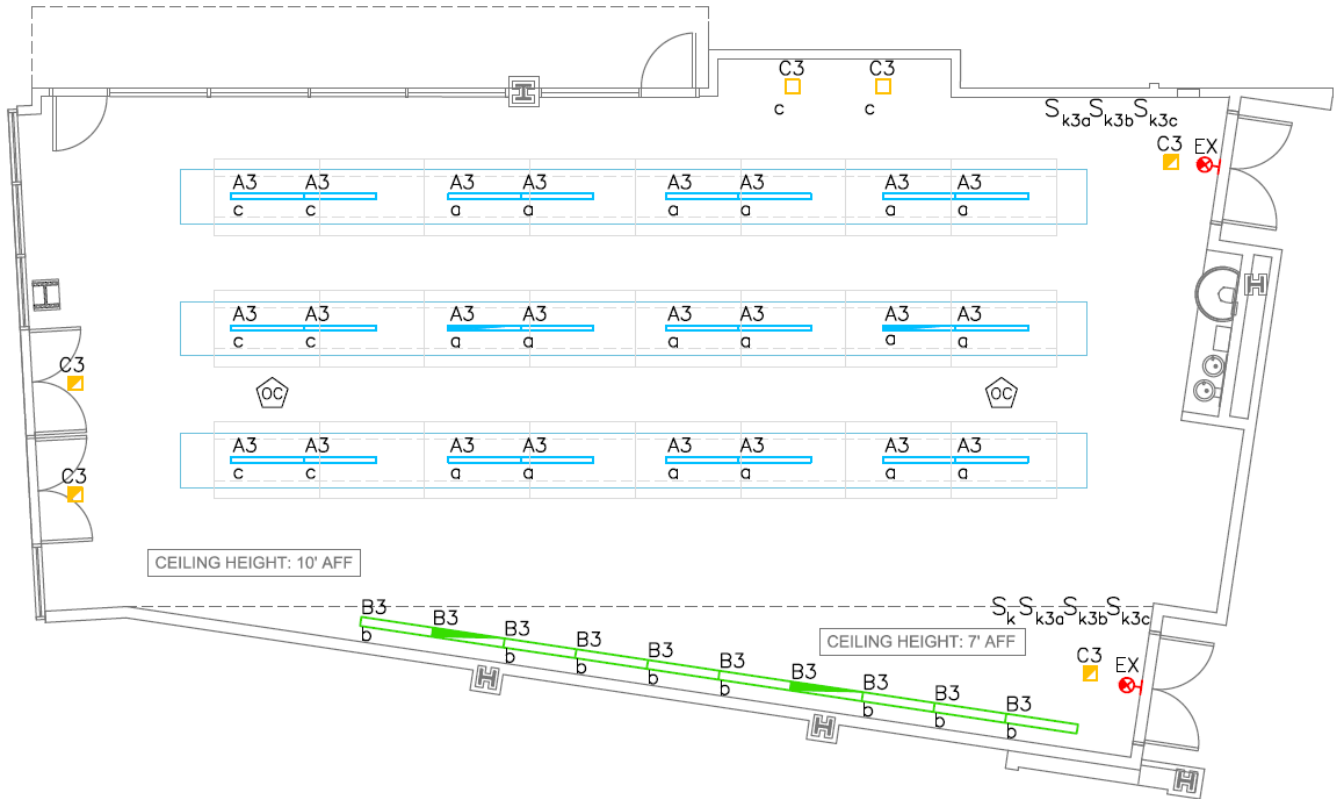
Average=18.89 Maximum=117 Minimum=2.4 Avg/Min=7.87 Max/Min=48.88









Value (Fc)	Color	Value (Fc)	Color
90	Red	5	Teal
40	Magenta		Brown
20	Blue		Purple
10	Green		Olive



Fixtures and equipment

The plan and fixture schedule presented below are intended to give a complete representation of the fixture specifications and placement within the space. Luminaires overhead—represented in blue—are recessed, four-foot, linear fluorescent fixtures that illuminate the hanging sculpture. The luminaires along the south wall—represented in green—are recessed linear fluorescent wall washers placed to uniformly wash the mosaic wall.



Fixture Schedule				
Type	Description		Manufacturer	
A3			Recessed linear fluorescent with flush .07" thick acrylic lens with opal satin finish. 22 ga. steel reflectors with high reflectance white powder coat. Matte White finish	Focal Point
B3			Recessed linear fluorescent wall washer. Housing and flange trim are die-formed, 20 ga. Steel, with gloss white finish. Semi-specular reflector	Peerless
C3			Recess 4.5"x4.5" square LED downlight. Matte white flange and reflector finish.	Lightolier
EX			Wall Mounted, single-sided exit sign. AC only operation with RED lettering on clear panel. Matte white finish on housing. 8" letters, 1" stroke	Mule Lighting

The tables below provide information regarding the energy consumption, assumed light loss factors, and load for the lamp-ballast combinations used for each of the luminaires used in the lighting of the Intermediate Schol Cafeteria. The IS Cafeteria contains a total of 42 lighting fixtures (including the exit signs). The lighting solution in consumes a total of 1,356 Watts (see ASHRAE/IESNA 90.1 under evaluation section). A light loss factor was not included for the exit sign (fixture 'EX') as it does not provide useful illumination to the room, and was not considered in any lighting calculations. It was, however, included in the energy consumption calculation of the space.

IS CAFETERIA VA CALCULATION								
Location	Type	Lamp	Qty	W/Fixture	Total Watts	PF	VA/Fixture	Total VA
IS Café	A3	(1) F32T8	24	38	912	0.9	42	1013
	B3	(1) F32T8	10	38	380	0.9	42	422
	C3	LED	6	9	54	0.7	13	77
	EX	LED	2	5	10	0.7	7	14

LIGHT LOSS FACTORS						
Type	Lamp Lumens		Light Loss Factors			
	Initial	Mean	LLD	LDD	BF	Total
A3	3000	2850	0.95	0.90	1.20	1.0
B3	3000	2850	0.95	0.90	1.20	1.0
C3	500	-	0.80	0.90	-	0.7
EX	-	-	-	-	-	-

Controls

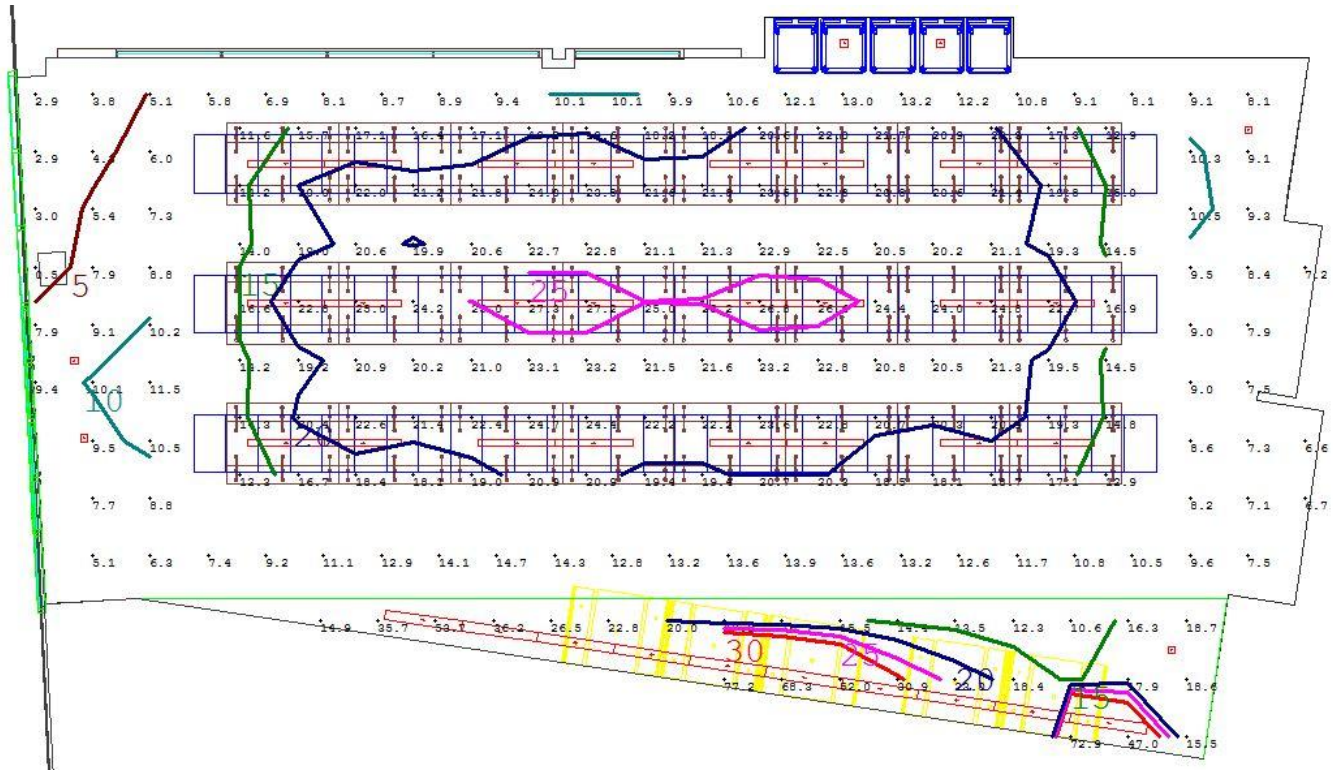
The luminaires in this space are grouped into 3 separate zones, all of which are connected to line-voltage occupancy sensors. Each zone has an override switch located at each of the two entrance doors to the space. All switches in the space are key-locked, meaning that they are only accessible via a physical key given the lunch aids or building maintenance staff.

Zone A controls the recessed linear fluorescent fixtures over the main table eating area. These are the fixtures that are recessed into the ceiling above the suspended sculpture, and are controllable so that they may be switched off when daylighting in the space is sufficient.

Zone B controls the recessed linear fluorescents wall-washers along the south wall atop the booth eating area. This zone may be switched if enough illuminance is provided on the eating surface via daylight or the lighting fixtures from zone A. Zone C controls the accent lights over the trash bin area. These may be switched as desired by the staff.

Calculation summary

Electric Light only



Statistics

Project 1
Calc Pts

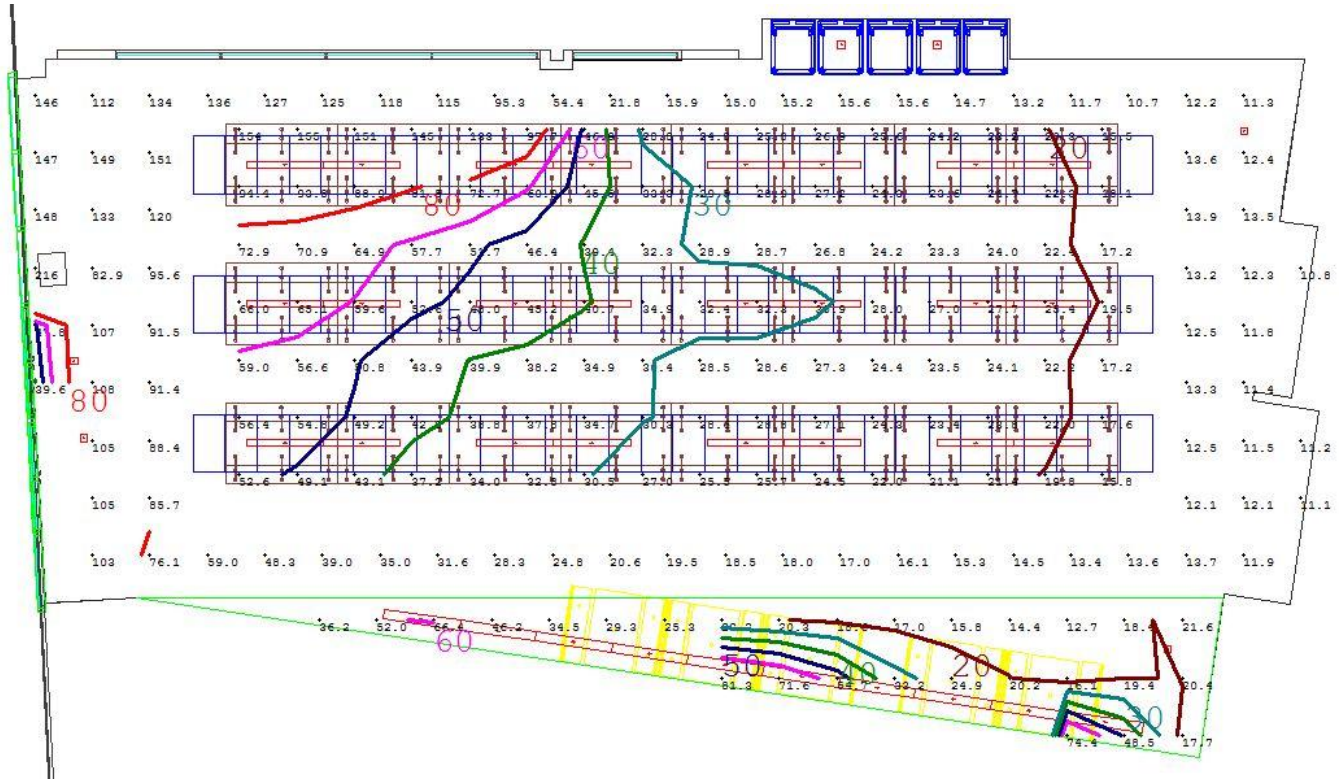
Benches
Illuminance (Fc)
Average=28.91 Maximum=78.2
Minimum=10.6 Avg/Min=2.73
Max/Min=7.38

Floor
Illuminance (Fc)
Average=9.11 Maximum=14.8
Minimum=0.5 Avg/Min=18.22
Max/Min=29.60

Tables
Illuminance (Fc)
Average=20.44 Maximum=27.3
Minimum=11.6 Avg/Min=1.76
Max/Min=2.35

Value (Fc)	Color	Value (Fc)	Color
30	Red	10	Teal
25	Magenta	5	Dark Red
20	Blue		Purple
15	Green		Olive

Electric Light and Daylight



Statistics

Project 1

Calc Pts

Benches
 Illuminance (Fc)
 Average=33.33 Maximum=81.3
 Minimum=12.7 Avg/Min=2.62
 Max/Min=6.40

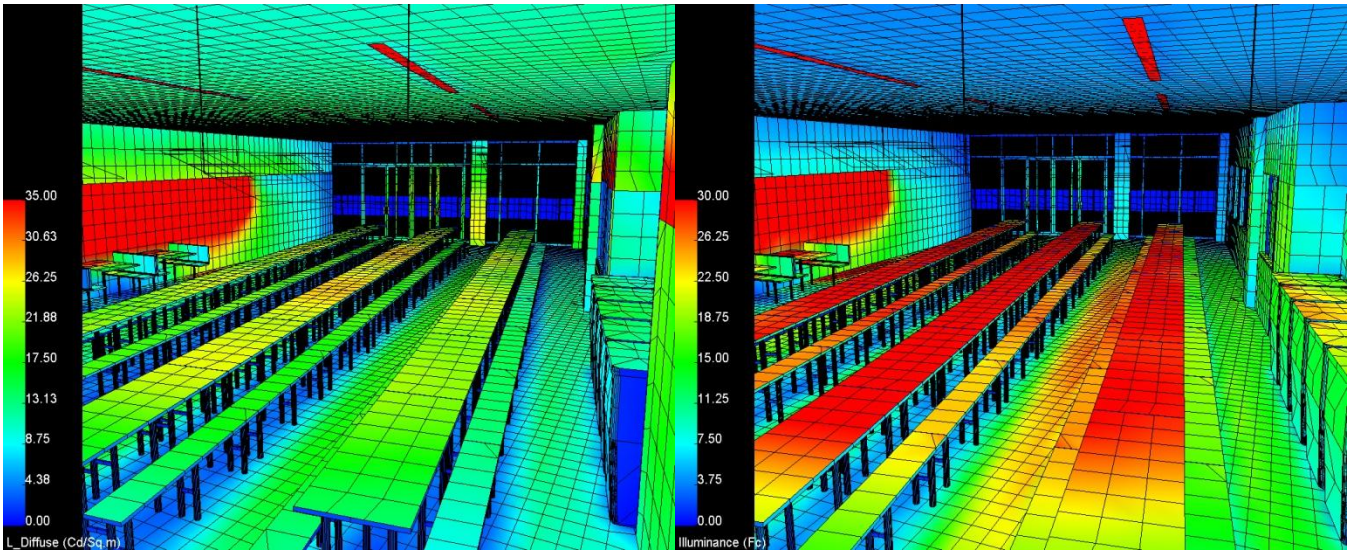
Floor
 Illuminance (Fc)
 Average=54.34 Maximum=216
 Minimum=10.7 Avg/Min=5.08
 Max/Min=20.21

Tables
 Illuminance (Fc)
 Average=42.02 Maximum=155
 Minimum=15.5 Avg/Min=2.71
 Max/Min=9.99

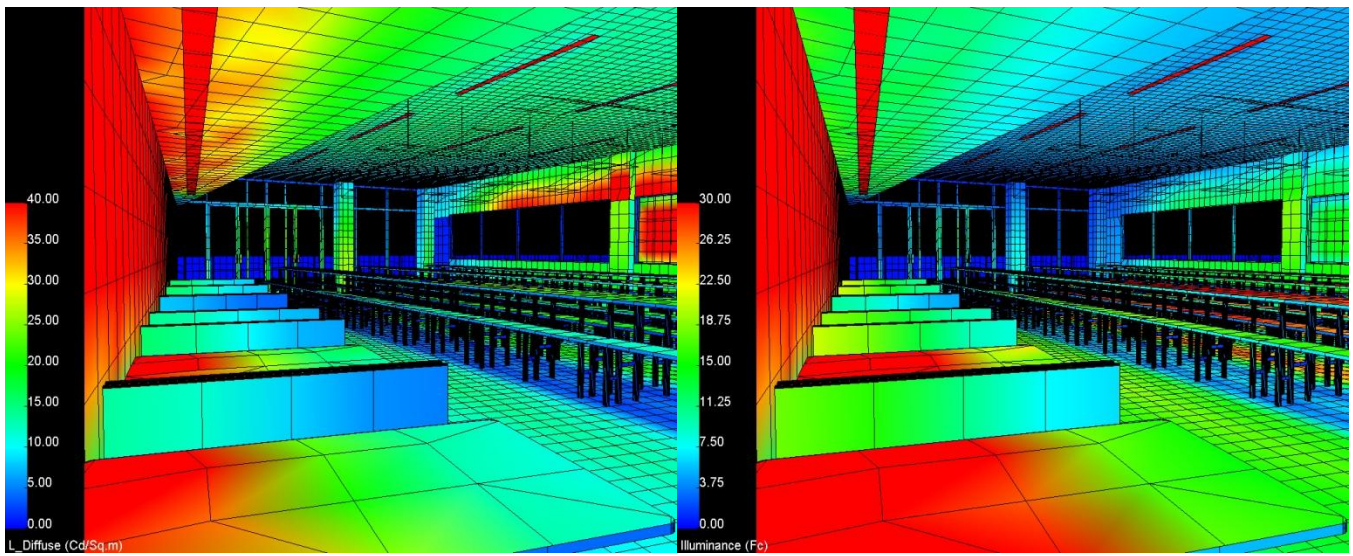
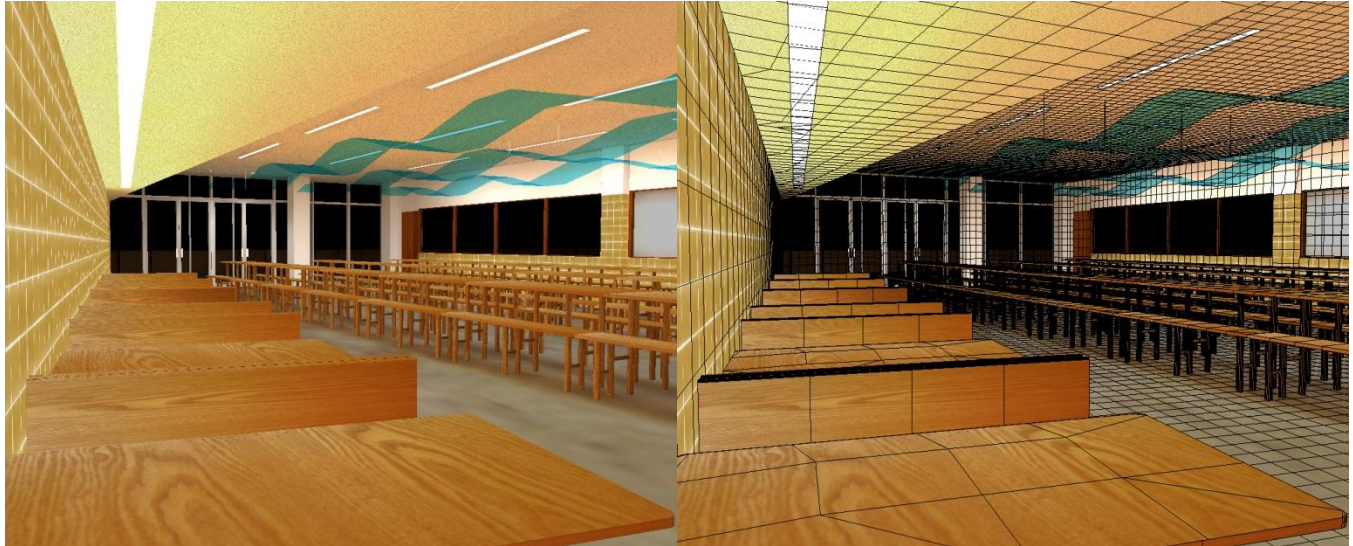
Value (Fc)	Color	Value (Fc)	Color
80	Red	30	Teal
60	Magenta	20	Brown
50	Blue	10	Purple
40	Green		Olive

Renderings

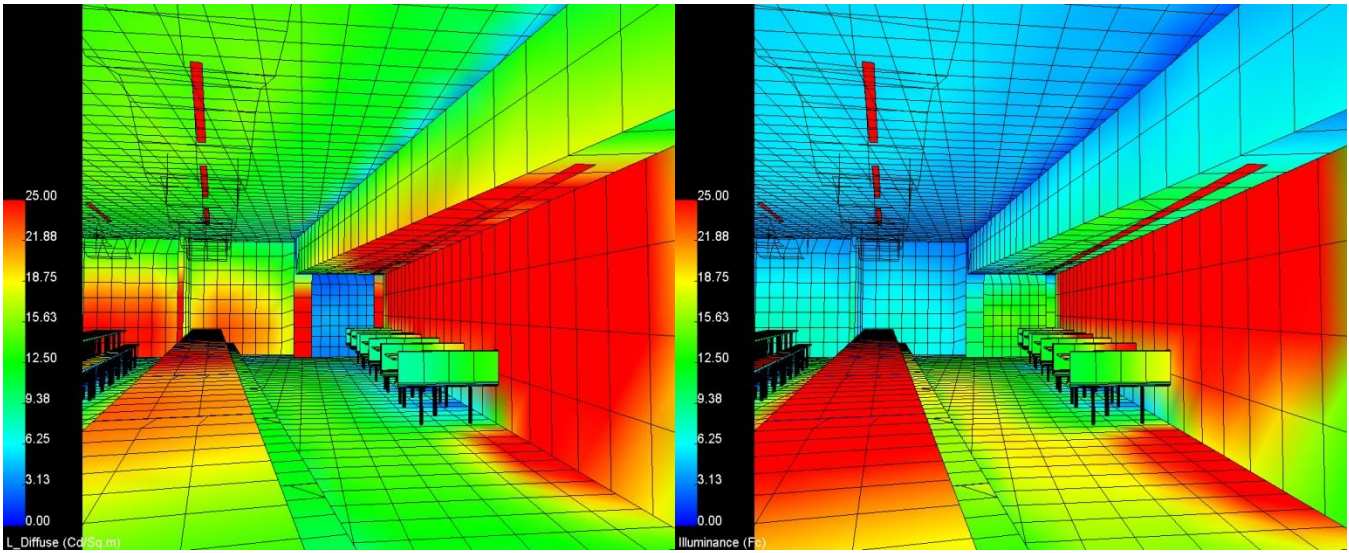
Electric Light Only

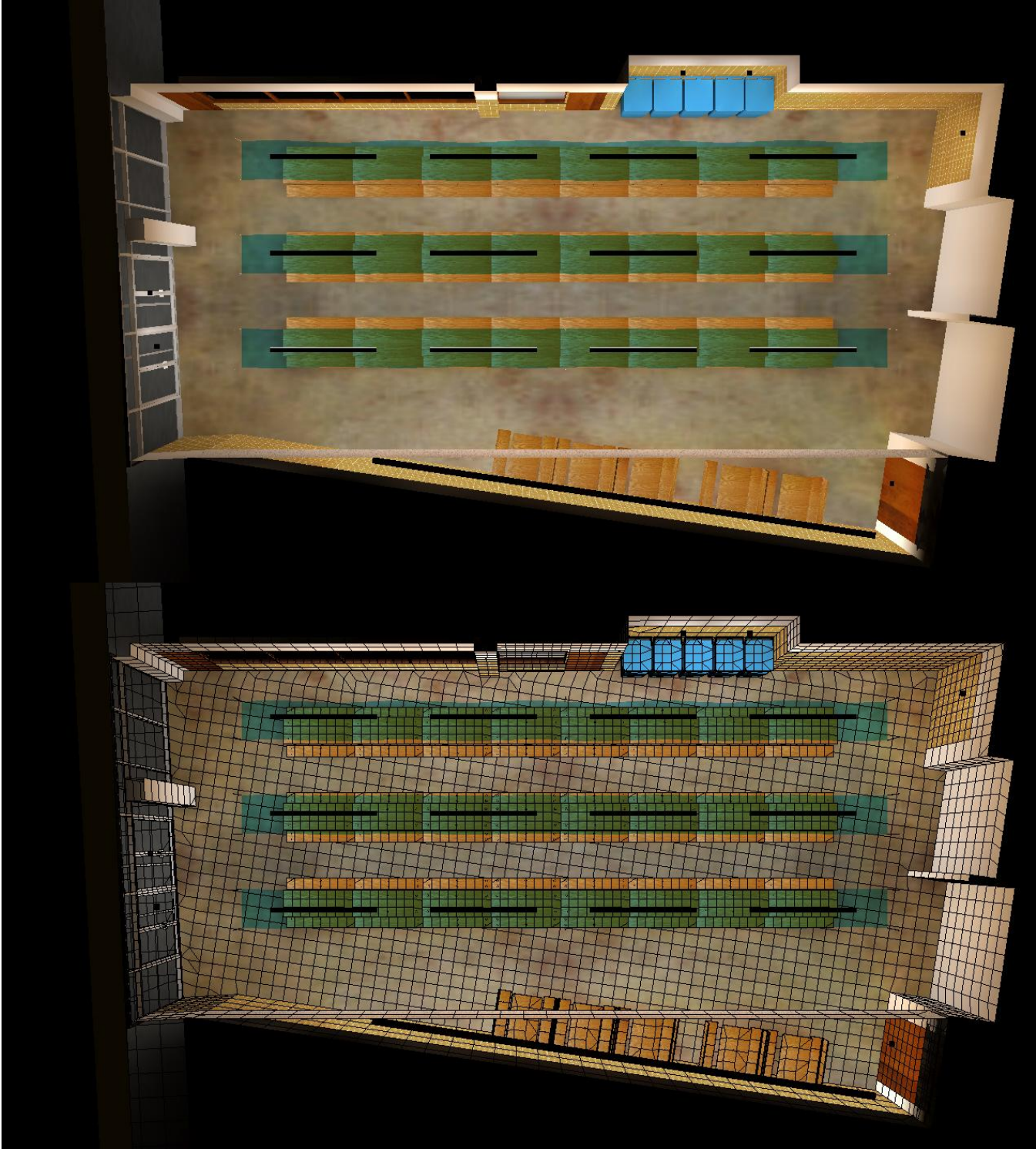


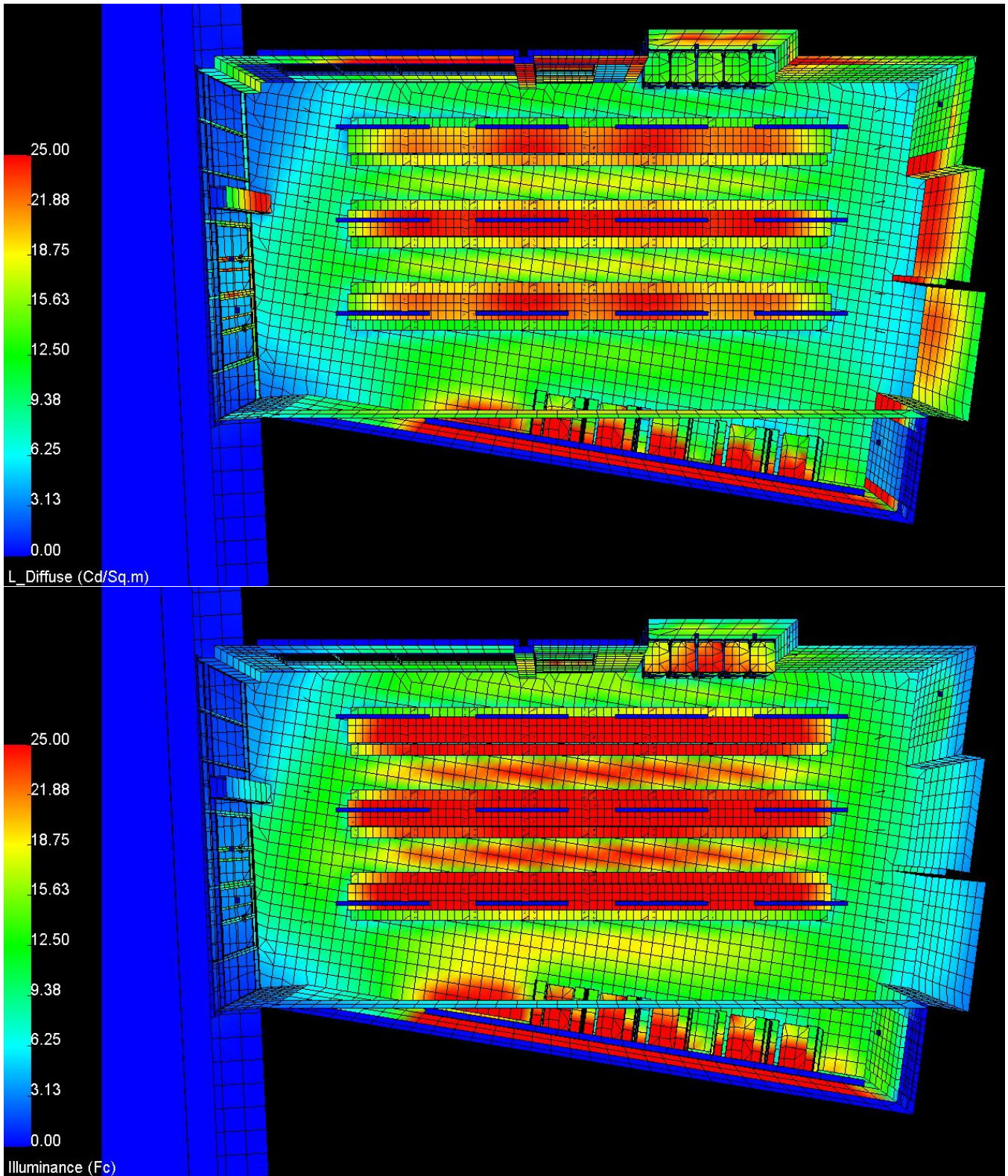
Electric Light Only



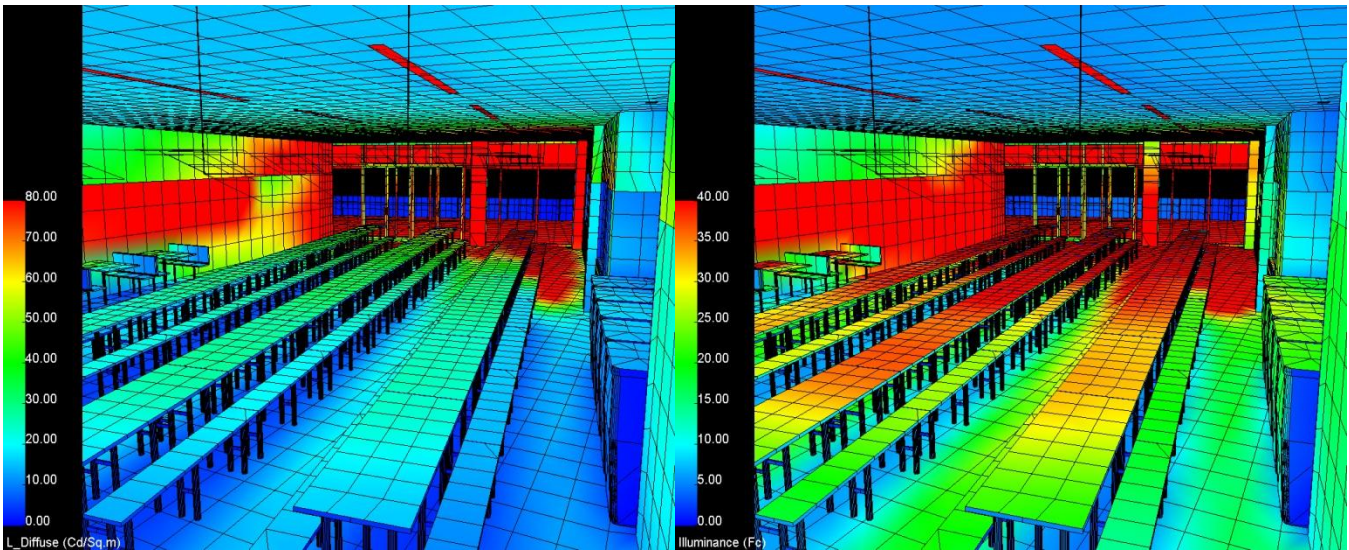
Electric Light Only



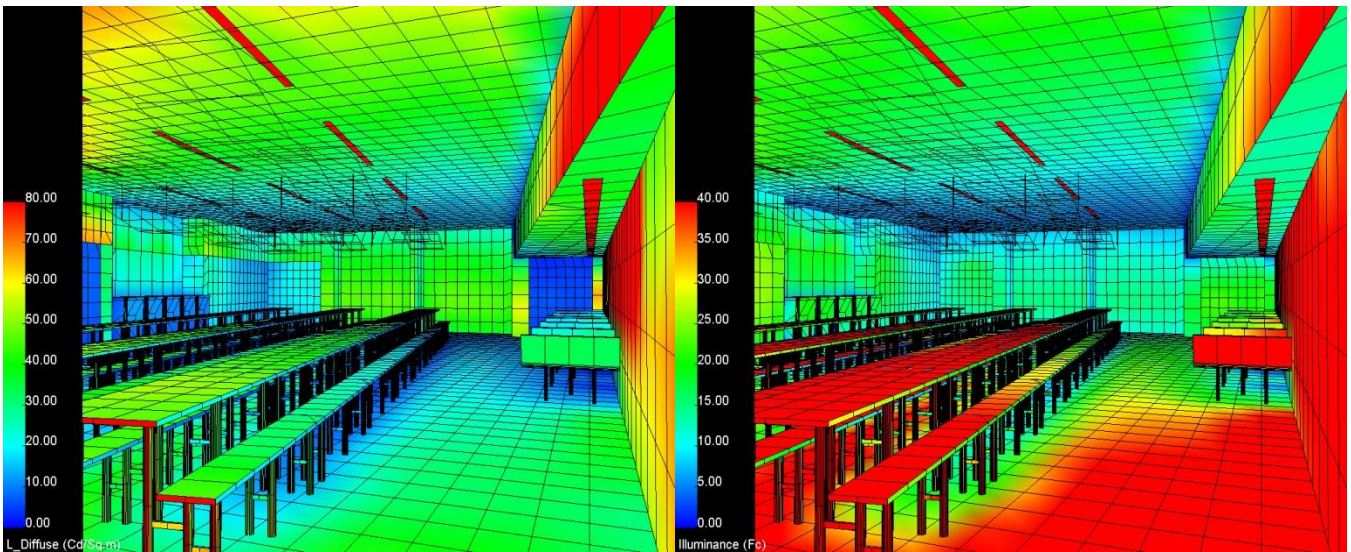
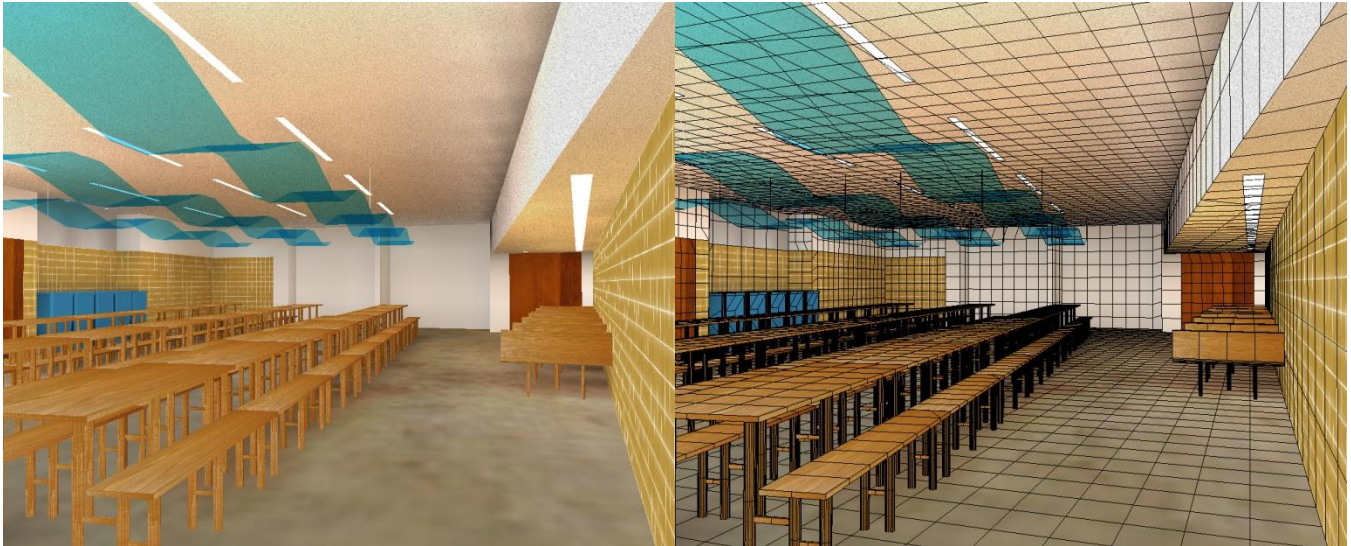




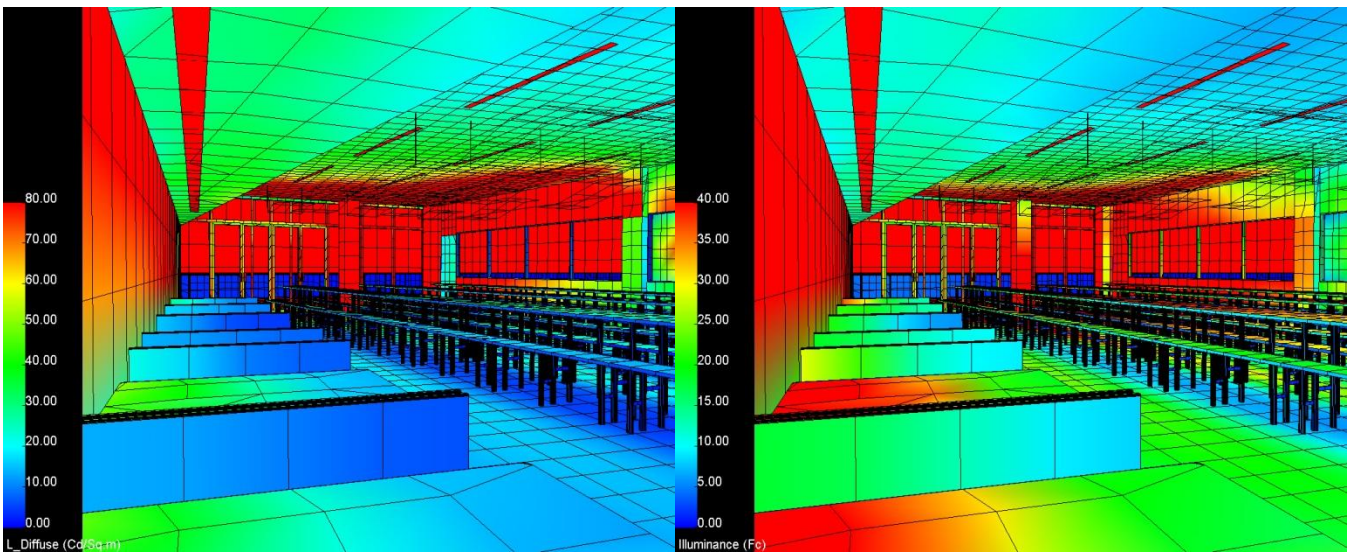
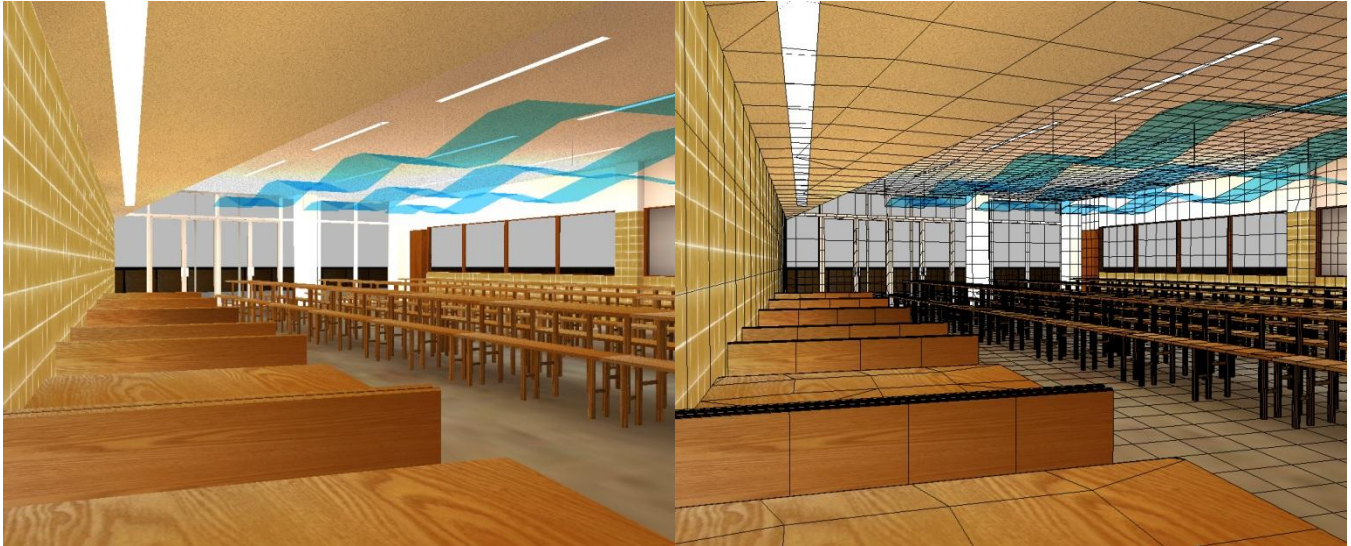
Electric Light and Daylight

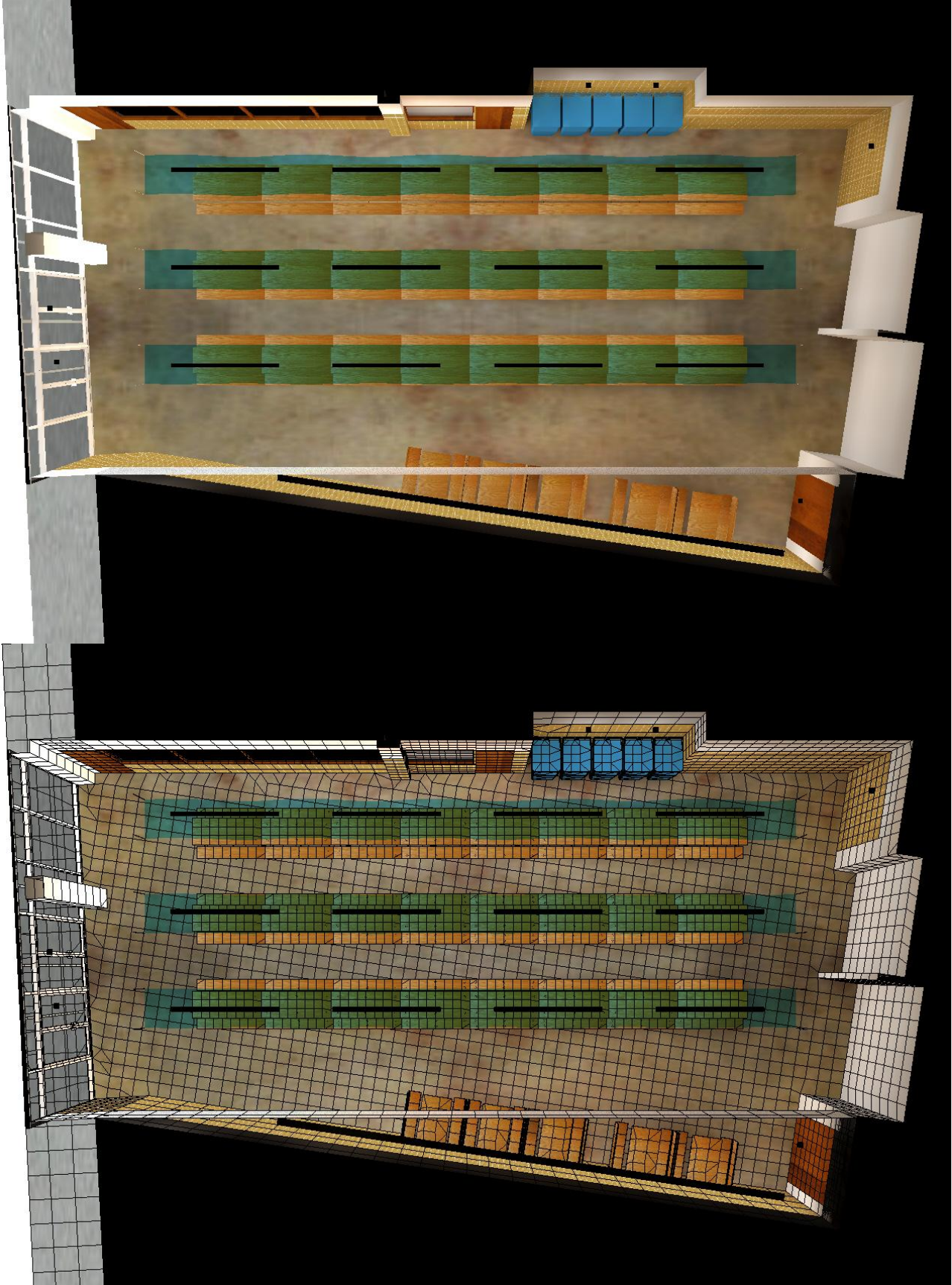


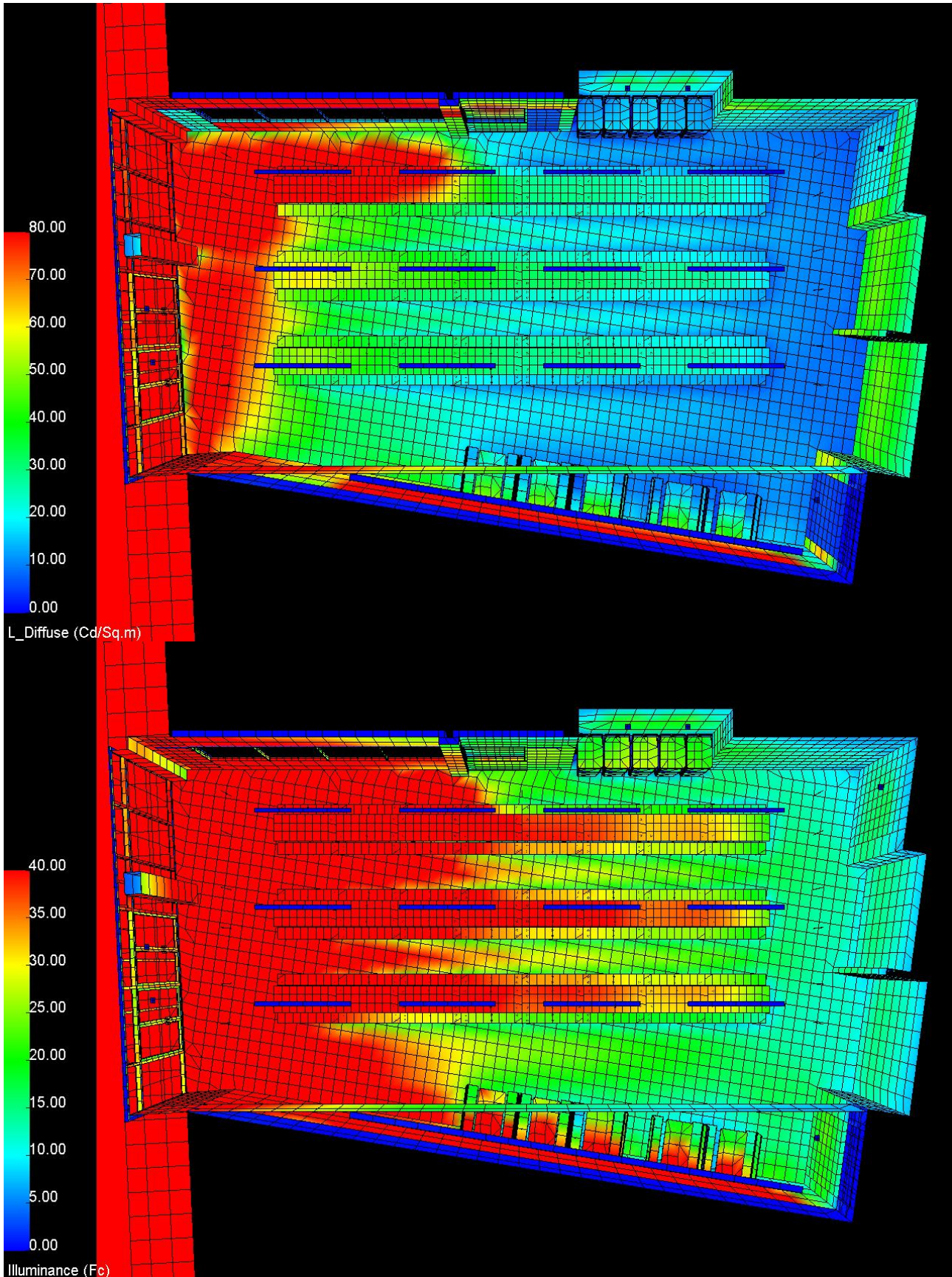
Electric Light and daylight



Electric Light and daylight







Evaluation

Summary

The design of the Intermediate School Cafeteria creates a more interesting environment than that of a standard middle school cafeteria. The addition of daylight, especially because the façade is predominantly north facing, should create a more natural feeling environment. Because the façade is north-facing, the daylight in the space will be mostly diffuse, which helps with creating a space with no glare. Daylight, being a natural light source, should help with the inherent problem of color rendering of cafeteria food. The fixtures in the space, which mimic the flow of the river that is in view out of the window, should make the space fun and interesting for the students. From a purely quantitative point-of-view, both IES illuminance recommendation and ASHRAE power densities were met (See next section). The primary concern may be the quality of light after it has passed through the hanging transparent-blue sculpture hanging from the ceiling. A further study should be conducted to verify the color rendering quality of the light passed through the sculpture.

ASHRAE/IESNA 90.1

As shown in the table below, the lighting solution for the Intermediate School Cafeteria consumes a total of 1,356 Watts which amounts to a power density of 0.64 watts/square foot.

IS CAFETERIA TOTAL INPUT WATTS				
Type	Lamp	Qty	Input W	Total W
A	(1) F32T8	24	38	912
B	(1) F32T8	10	38	380
C	LED	6	9	54
EX	LED	2	5	10
			Total:	1356

ASHRAE/IESNA 90.1 2011		
Category	Allowable	Actual
Area (sq.ft.)	-	2115
Input Watts (W)	1375	1356
Power Density (W/sqft)	0.65	0.64

4 | High School Art Room

This section, dedicated to the documentation of the lighting design solution for the High School Art Room, contains all information pertinent to fully describing the space and lighting design. Included are the design goals and criteria, utilized fixtures and equipment schedules, control descriptions with appropriate diagrams, calculation summary as quantitative description of the design, renderings of appropriate views, and an evaluation comparing the design solution against the design goals set at the outset of the design. The daylighting analysis for this space is not included in this section. As the High School Art Room was the subject of the MAE daylighting analysis, the analysis and results are outlined in that section. This section is outlined as follows:

Description

Space Location

Finishes

Furnishings

Tasks/Activities

Overall Design Goals

Design Criteria/Considerations

Illumination Recommendations

Design Considerations

Daylighting

See MAE Breadth

Fixtures and Equipment

Controls

Calculation summary

Renderings

Evaluation

Summary

ASHRAE/IESNA 90.1

Description

Area: 1250 ft²

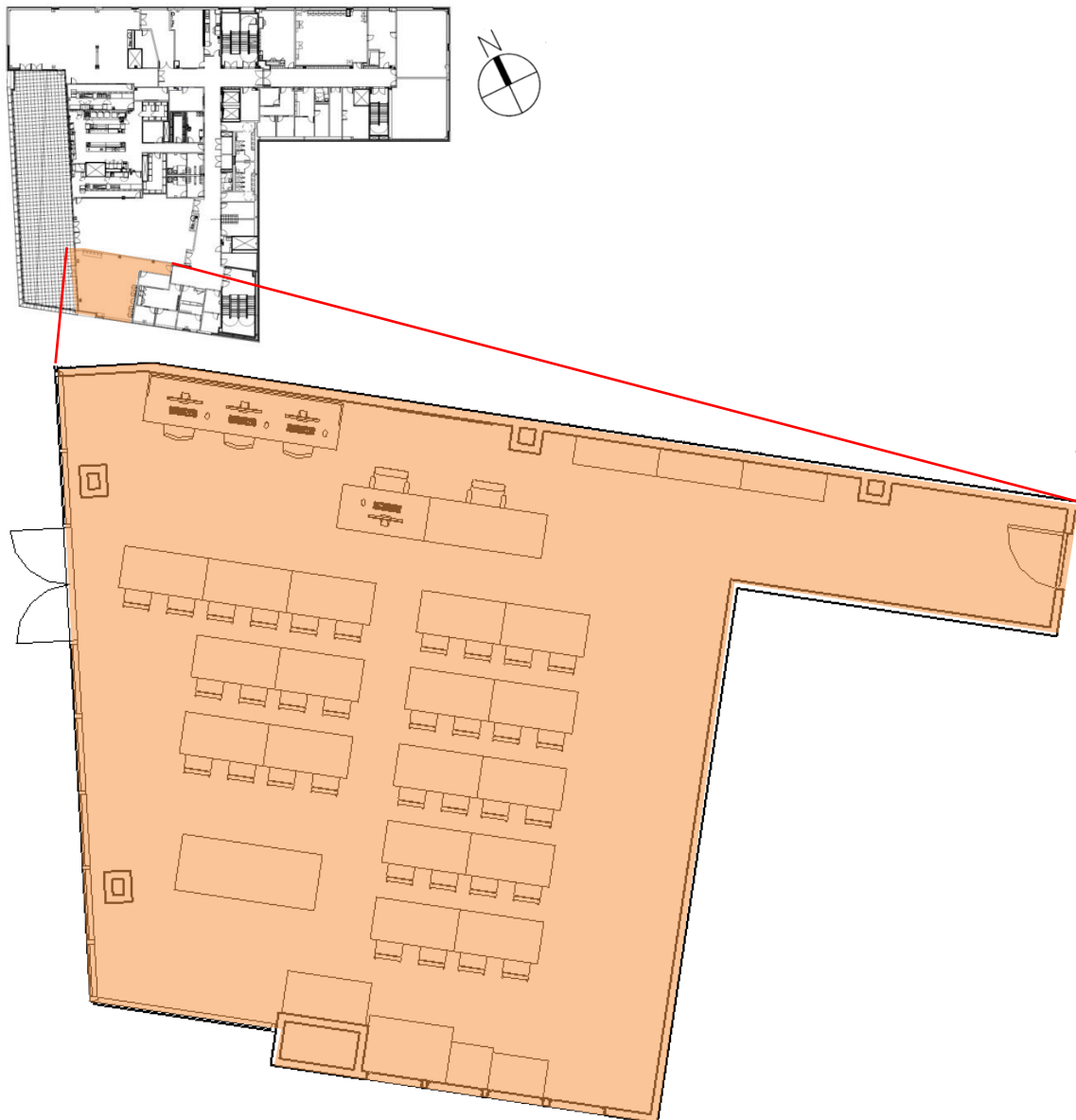
Length: 33 ft.

Width: 54 ft.

Ceiling Height: 10 ft.

Location (in building)

The Intermediate School (IS) cafeteria is located on the 5th floor directly (plan) north of the High School (HS) Art Room. There is no direct circulation between these two rooms, but like the High School Art room, the cafeteria has direct access to the exterior roof terrace. The two doors, located on the western side of the North wall, lead to the lunch line, which is linked directly to the kitchen.



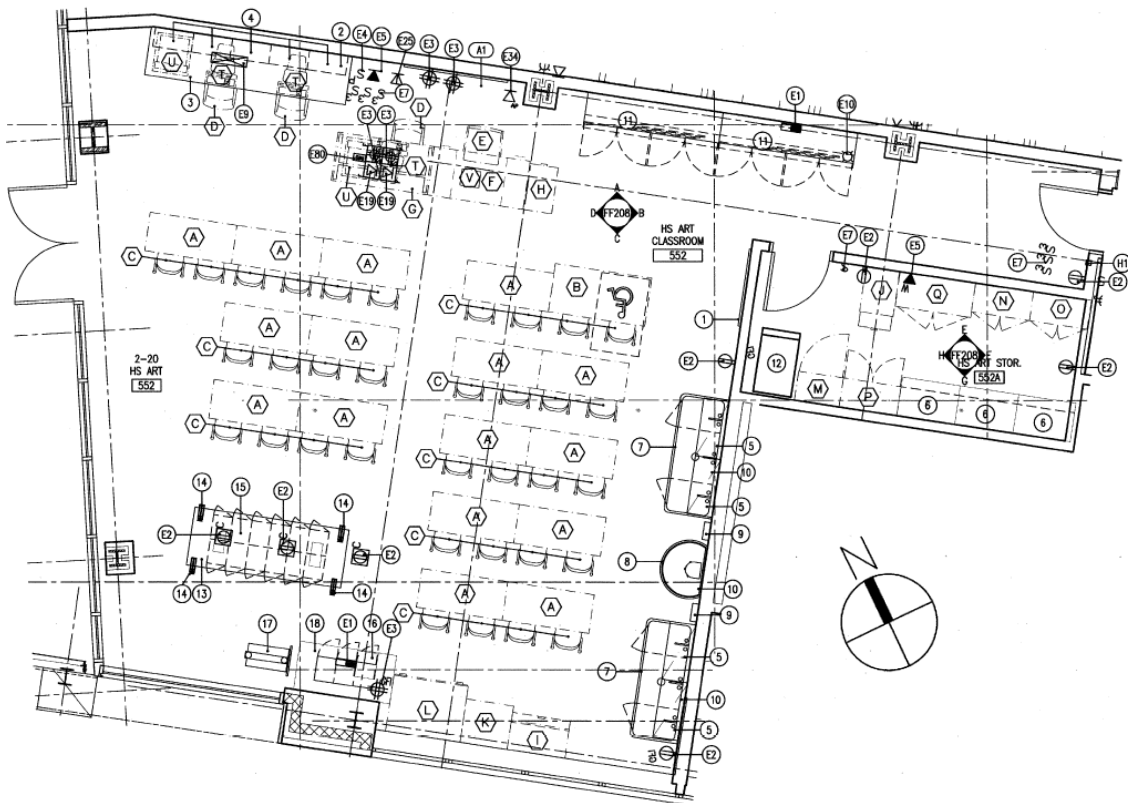
Finishes

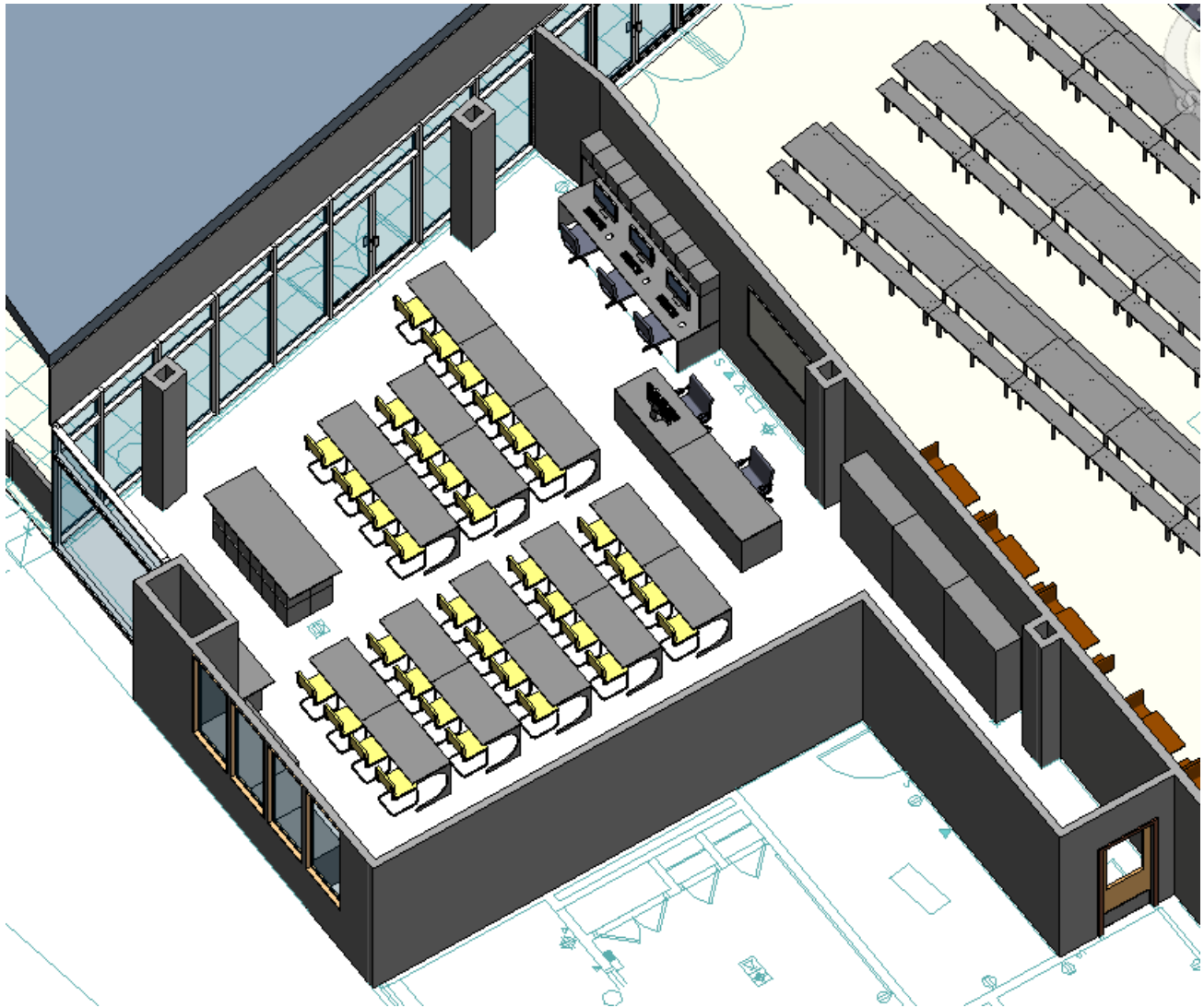
The floor of the High School Art Room is comprised of 12"x12" composite vinyl tile that is pewter in color. The walls, finished with high-reflectance white semi-gloss paint, are ideal for light distribution in the space. The ceiling, which was originally an acoustical drop ceiling, has been removed to expose the systems in the ceiling. See MAE and CM breadth.

Materials				
Surface	Material	Description	Style/Color	Reflectance
Floor	VcT	12" x 12" Vinyl Composition tile	112 Pewter	0.30
Walls	SG-P	Semi-Gloss Paint	Simply White OC-117	0.85
Ceiling	None	No drop ceiling. Open to above	N/A	N/A

Furnishings

The HS Art Room has seating for 34 students (1 handicap). The front wall of the room has a 2-seat computer desk, a large storage cabinet, and a marker-board and tack-board. For cleaning purposes, there are 2 large trough sinks and a wash fountain located on the west wall. Located on the back wall of the room (from left to right), are the following: etching press, jewelry kiln, cabinet/plan file drawer, flat file drawer, and a 3-drawer lateral file cabinet. Also located towards the back of the room in the South-West corner is a large work bench.





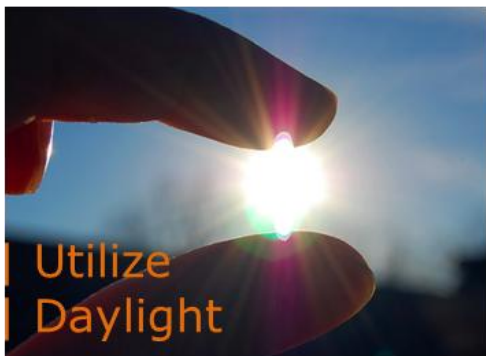
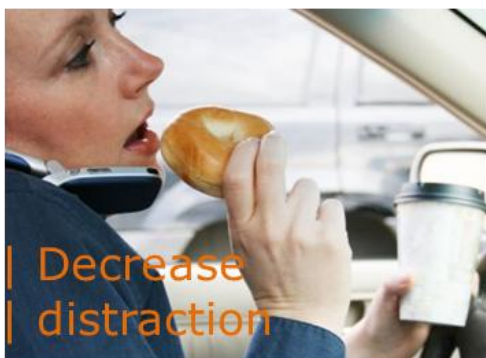
Tasks/activities

The primary tasks in this space consist of the creation of (and possibly the critique and appreciation of) art. This room is equipped with a substantial amount of equipment as to facilitate the creation of art in many different forms (painting, drawing, sculpture, etc.).

Although secondary in importance to the actual art creation taking place at the students' desk, formal lectures and "pin-ups" will also be taking place in this room. The marker-board and tack-board on the front wall of the room supports these tasks.

Overall design goals

The High School Art Room is a great space to design as it has limitless possibilities. Its location and orientation within the building and orientation allow for interesting possibilities with daylight. As this is a space that will be used to study and create art, the space itself should be a work of art. The intrinsic artistic nature of the use of this space opens the door to trying things that may not be appropriate in other spaces. This space, if any, should work towards achieving the overall design goal of **lighting + architecture**.



Promote Creativity: The space is an art room. Nothing about the space itself should be bland or boring. An art room itself should be a work of art. It should inspire. It should lead by example, if you will.

Decrease Distraction: The focus should be on creating art. Not glaring or inappropriate lighting.

Utilize Daylight: The location and orientation of the space, as well as the floor to ceiling glazing on two facades, floods the space with lighting. This should be utilized as much as possible.

Lighting as a tool for education: what defines art? If this space is to be used to teach art, why couldn't it be used to educate students about the affects lighting has on people and object?

Design Criteria/Considerations

Illuminance recommendations

Horizontal Illuminance – Important

- IES Classification: Education – Classrooms – Art Studios
 - Category R: 250 lux (25.0 fc)
 - Avg/Min: 3:1

Horizontal illuminance in the High School Art Room is important for artwork that will be created on a horizontal work surface (i.e. the students' desks). These types of works include, but are not limited to, the following: pencil/colored pencil/marker/charcoal/pastel drawings and watercolor/acrylic/oil paintings.

Vertical Illuminance – Important

- IES Classification: Education – Classrooms – Art Studios
 - Category P: 150 lux (15.0 fc)
 - Avg/Min: 3:1

The vertical levels in the art room are important, but not necessarily for the typical reason of face recognition. Although facial recognition is important, especially for a classroom, clear viewing of artwork is the primary concern here. These illuminance levels are critical to the production of artwork that is not necessarily produced on a two-dimensional surface. These types of work include, but are not limited to, the following: watercolor/acrylic/oil paintings, paper mache/plaster of paris/clay sculpture.

Design Considerations

Appearance of Space and Luminaires – Very Important

The lighting in this space is aimed to inspire; to motivate to create great works of art. The space, which should be a work of art itself, requires a creative lighting design. The luminaires should complement the design.

Color Appearance and Color Contrast – Very Important

Color rendering and contrast is extremely important especially when it comes to painting and drawing with color. Oil painting, which has very deep saturated colors, requires high color rendering capabilities of luminaires.

Daylighting Integration and Controls – Very Important

Besides the fact that daylight integration is one of the main design goals of the lighting design in this space, daylight integration in general is an important factor to consider in any space that has a large percentage of

wall area dedicated to glazing. Daylight integration is a requirement of this space. The controls, depending on the results of a daylighting analysis (see MAE breadth) may or may not be required.

Direct Glare – *Very Important*

As this space is aimed at utilizing daylight as much as possible, and is oriented in such a way that direct sun falls on the façade very often, direct glare is of high importance and needs to be thoroughly investigated. In addition to being irritating, direct glare from the sun can be distracting and may affect the process of creating great pieces of art.

Flicker – *Somewhat Important*

Flicker itself is an important design consideration and should be avoided whenever possible. However, there is no added importance of flicker in this space than normal. That is, there are no critical tasks in this space that require additional attention to flicker.

Light Distribution on Task Plane – *Important*

The task plane should be uniform enough so as to not distract from the task at hand—which is creating art. However, the task plane should not be overly uniform, as to wash out the detail in paintings and drawings.

Modeling of Faces or Objects – *Somewhat Important*

Modeling of faces is important, but that of objects is extremely important. Sculpture and pottery are two forms of art that require a large physical object. Lighting needs to provide illuminance as to properly model the fine detail required when sculpting.

Reflected Glare – *Very Important*

Glare reflected from surfaces in the space is a very important problem, especially as the ceiling will be removed, exposing the systems in the ceiling. They must be finished with matte white paint to reduce the possibility of reflected glare.

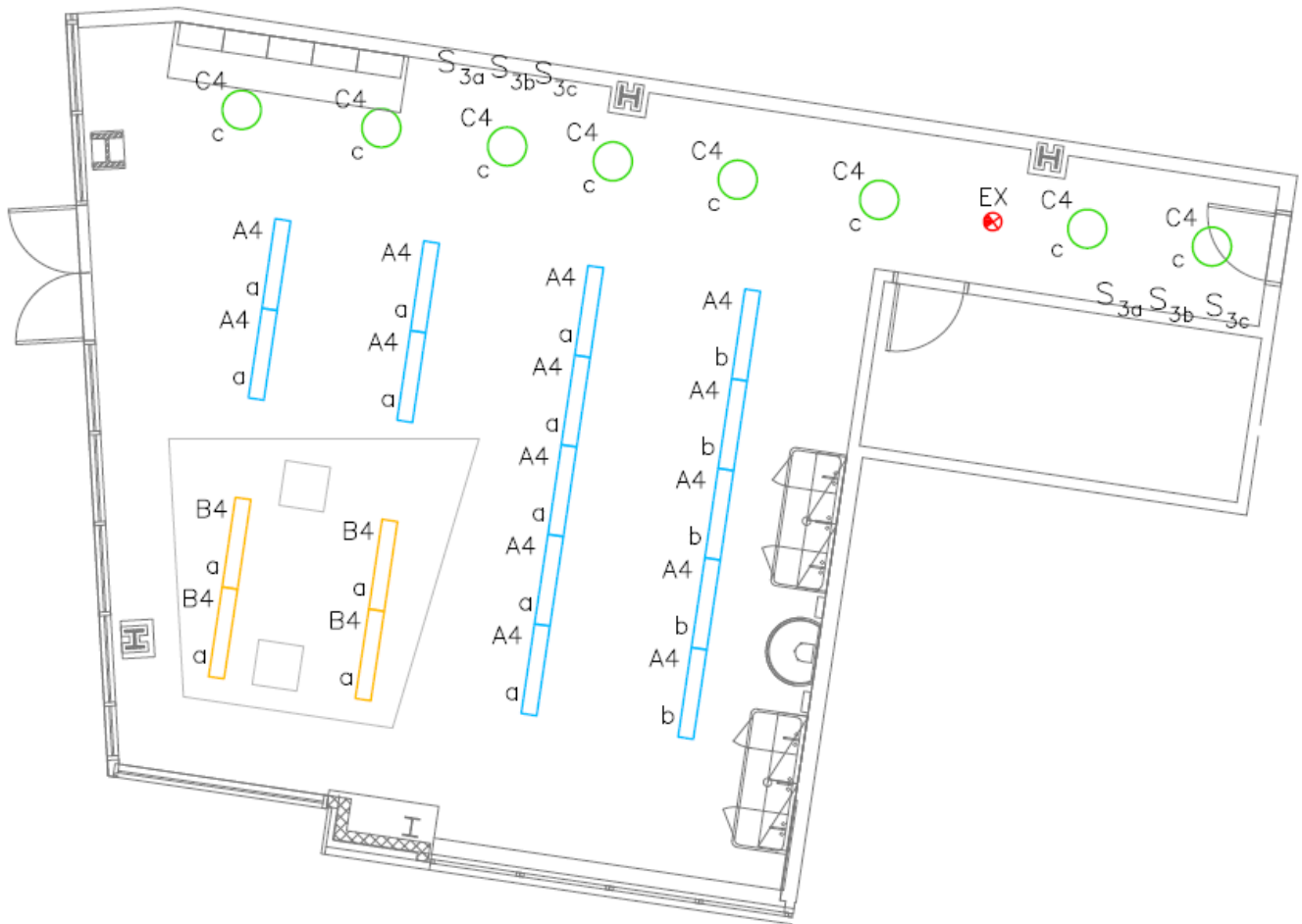
Shadows – *Important*









Shadows, although desirable in some situations, should be avoided in this space—at least for the most part. Direct lighting overhead can cast shadows on the work surface and distract from the task at hand. Wherever possible, shadows from the general lighting in the space should be avoided. Shadows shall only be introduced into the space where important for artistic demonstration.

Daylighting

See M.A.E Daylighting Breadth

Fixtures and equipment



Fixture Schedule				
Type	Description			Manufacturer
A4			Single-lamp, Suspended linear fluorescent semi-indirect pendant with die-formed specular reflector. Reflector 95% reflective. Aluminum semispecular parabolic louver.	Peerless
B4			Single-lamp, recessed linear fluorescent semi-indirect pendant with die-formed specular reflector. Reflector 95% reflective. Aluminum semispecular parabolic louver.	Peerless
C4			Suspended, 26W 3500k compact fluorescent, downlight. 14 ga. Single-piece precision-spun aluminum. 14 ga. Anodized aluminum reflector with diffuse satin matte surface.	Focal Point
EX			Ceiling-Mounted, single-sided exit sign. AC only operation with RED lettering on clear panel. Matte white finish on housing. 8" letters, 1" stroke	Mule Lighting

The tables below provide information regarding the energy consumption and assumed light loss factors for each of the luminaires used in the space. The room contains 27 fixtures, consuming a total of 969 Watts. A light loss factor was not included for the exit sign (fixture 'EX') as it does not provide useful illumination to the room, and was not considered in any lighting calculations.

HS ART ROOM VA CALCULATION								
Location	Type	Lamp	Qty	W/Fixture	Total Watts	PF	VA/Fixture	Total VA
HS Art Room	A4	(1) F32T8	14	38	532	0.9	42	591
	B4	(1) F32T8	4	38	152	0.9	42	169
	C4	(1) 32CFTR	8	35	280	0.9	39	311
	EX	LED	1	5	5	0.7	7	7

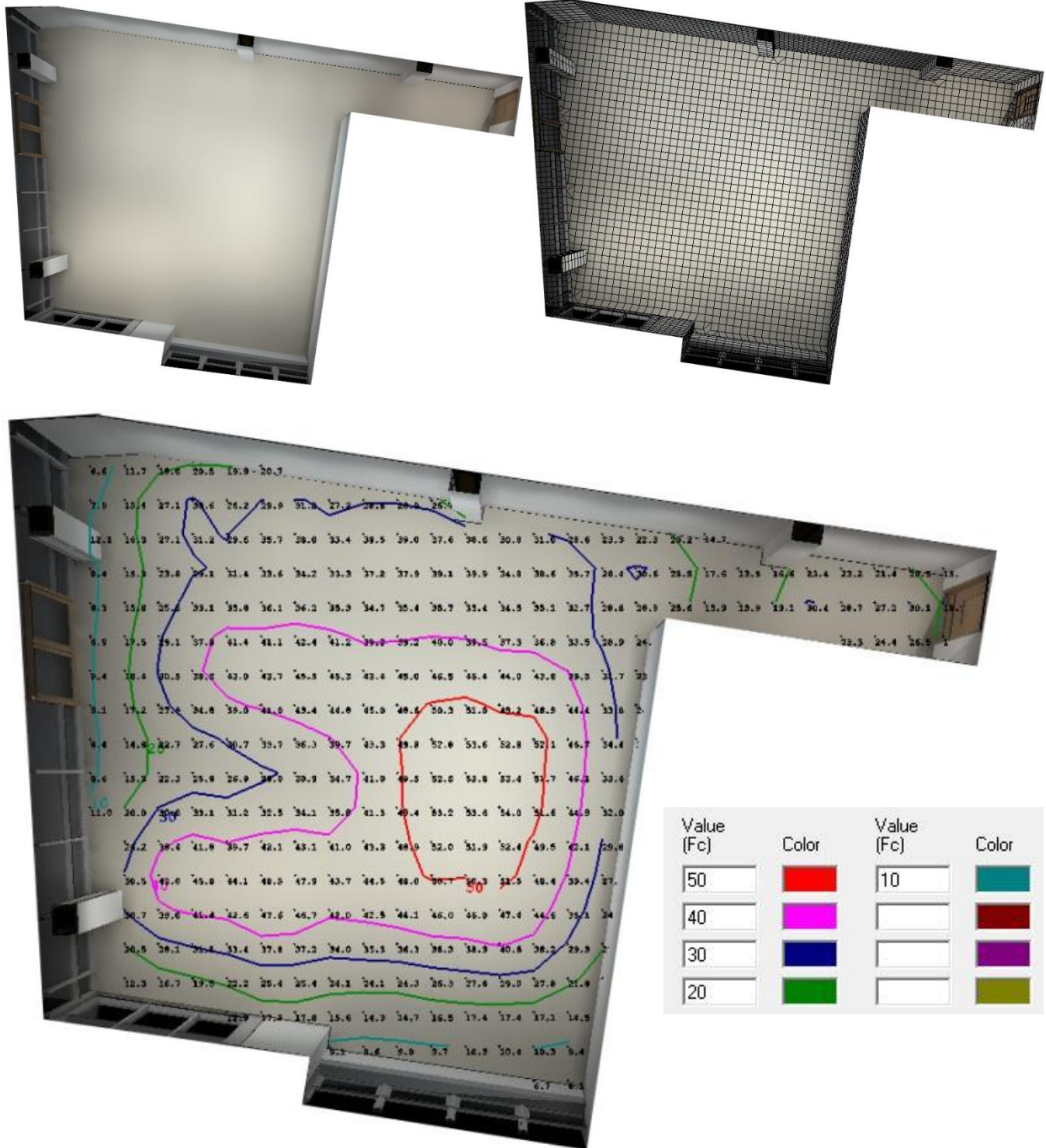
LIGHT LOSS FACTORS						
Type	Lamp Lumens		Light Loss Factors			
	Initial	Mean	LLD	LDD	BF	Total
A4	3000	2850	0.95	0.90	0.88	0.8
B4	3000	2850	0.95	0.90	1.20	1.0
C4	-	-	0.70	0.90	-	0.7
EX	-	-	-	-	-	-

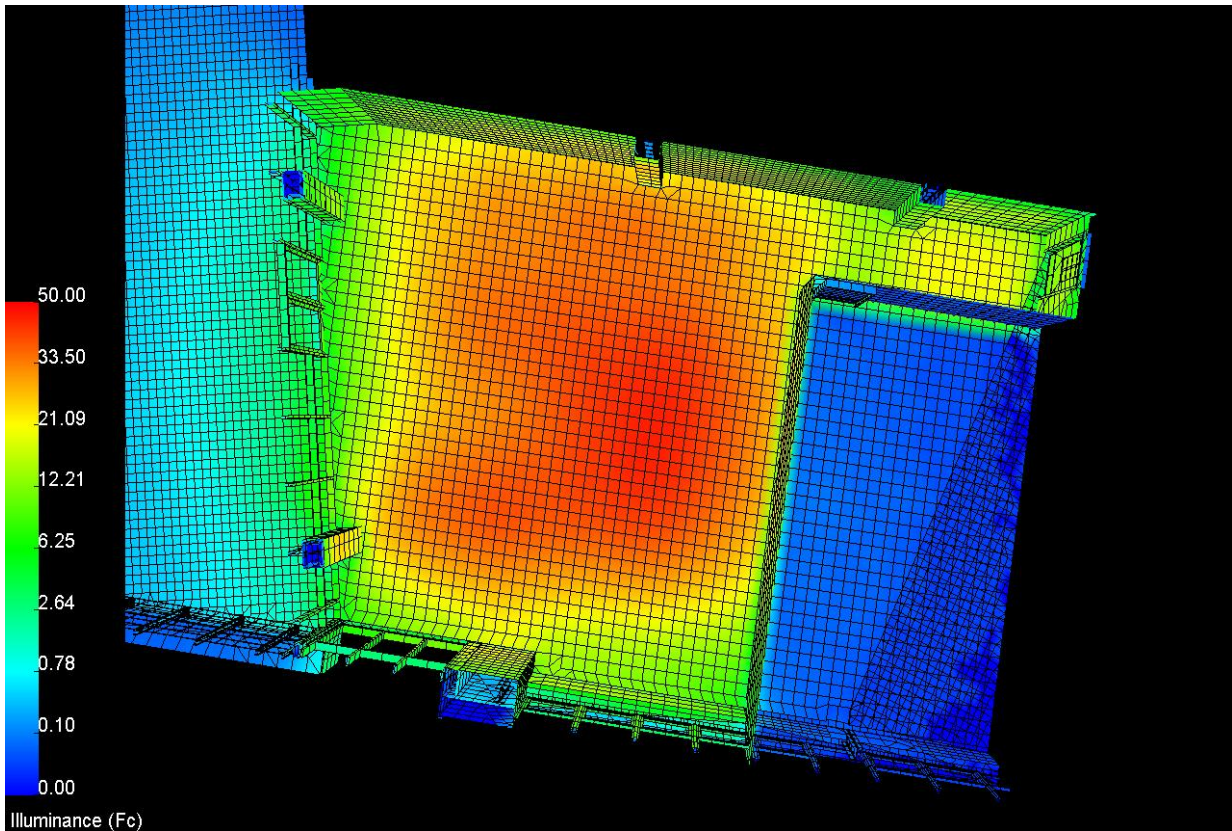
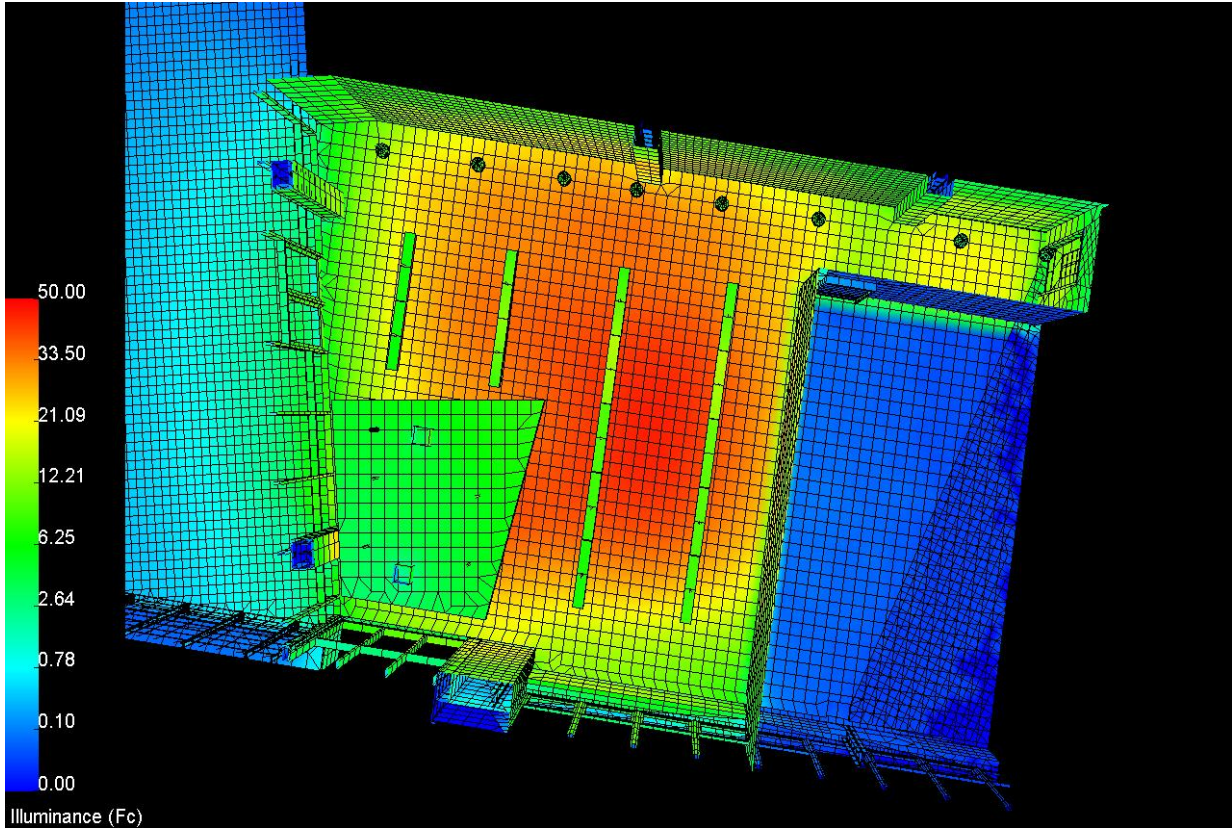
Controls

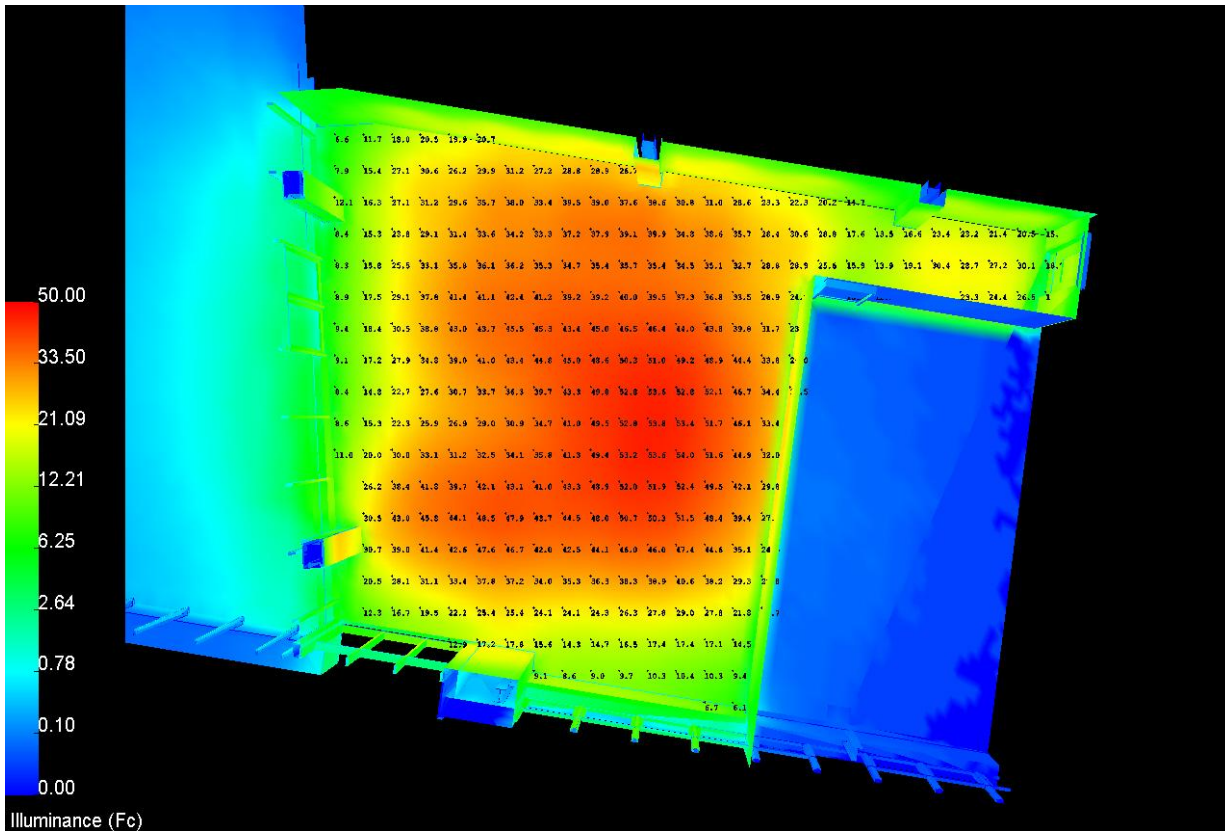
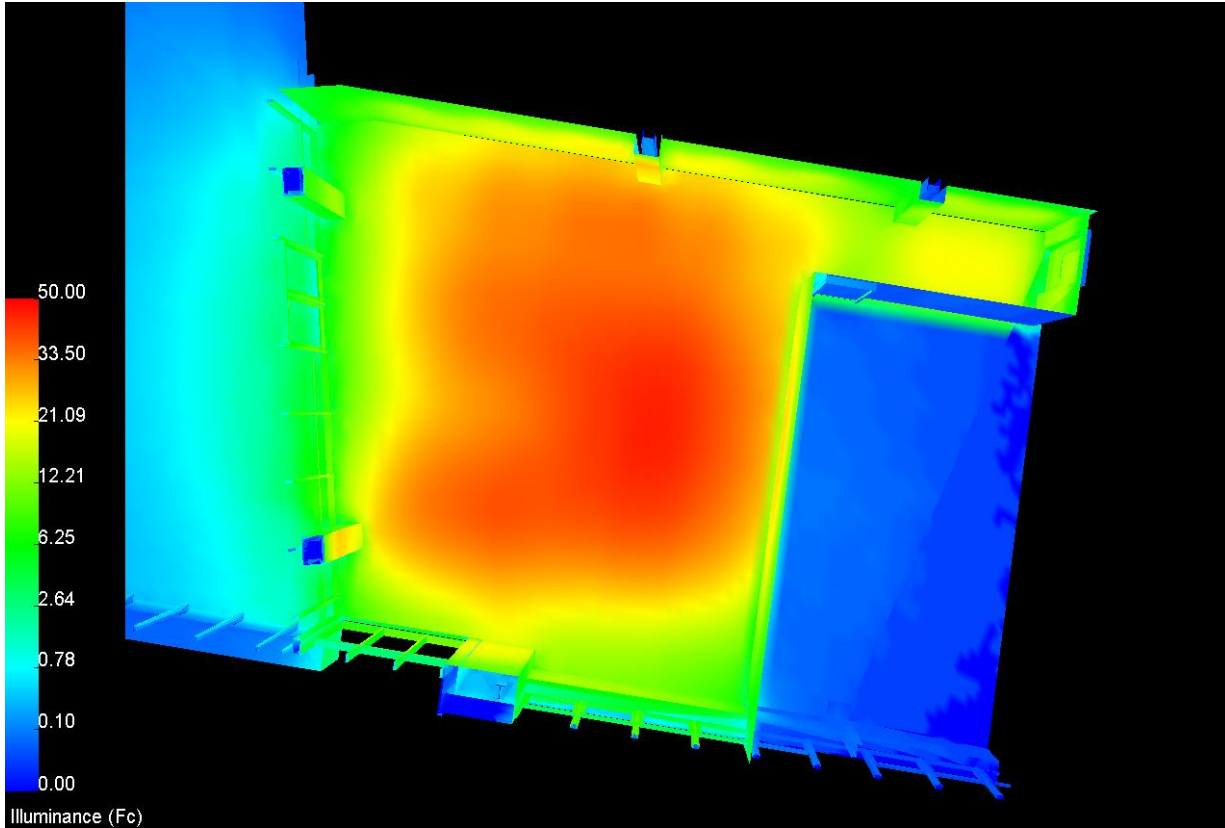
The High School Art Room has a three-zone configuration with switches at two locations; a set at the entrance door to the space, and another to the rear of the teacher's desk by the whiteboard. The suspended compact fluorescent fixtures at the front of the space are on their own zone in the event that daylight provides sufficient illuminance to the rear and middle area of the space, but emphasis is desired in the front of the class; for a lecture, perhaps. The suspended linear fluorescents over the students seating area is broken into two zones. The run of fixtures nearest the east wall are zone separately as this tends to be the area that receives the least daylight and is the location of the sinks and cleaning equipment. These luminaires may be switched on if daylight does not provide sufficient illuminance levels in this area. Luminaires in this space do not have dimming capabilities and are not controlled by photosensors. The daylight and skylights were designed (See MAE Breadth) as to provide sufficient illuminance through most of the occupancy schedule. Therefore, it was deemed redundant to put automatic controls in as the space is design to not need electric light. As such, all lighting is manually operated.

Calculation summary

The figures below show the calculation summary for the High School Art Room. The image in the top row to the left shows the distribution of light in the space. The image to the right shows the space with the calculation mesh. The bottom image shows the calculation points and isolines with corresponding values.

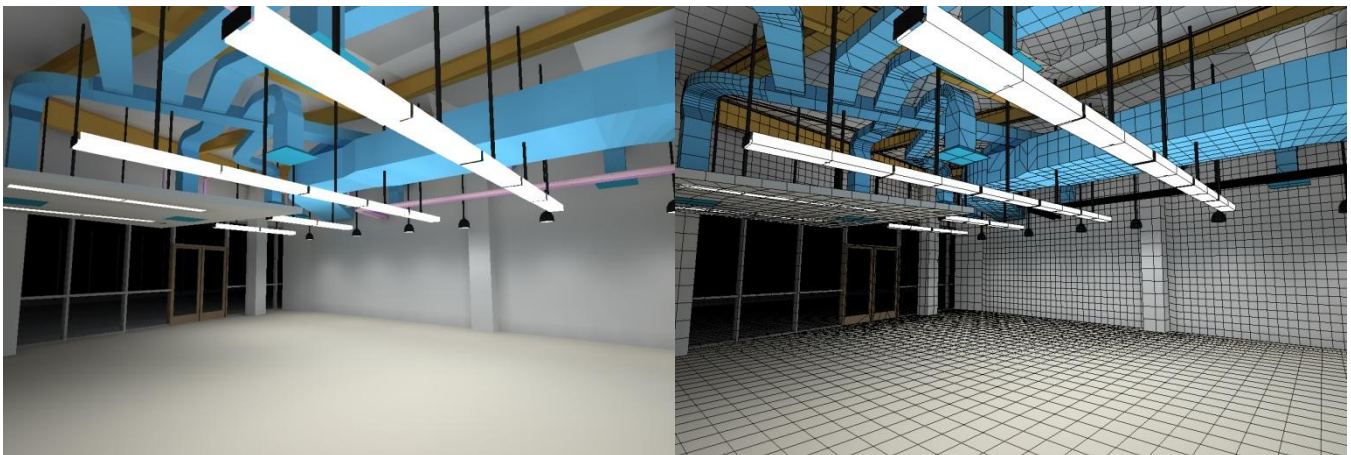
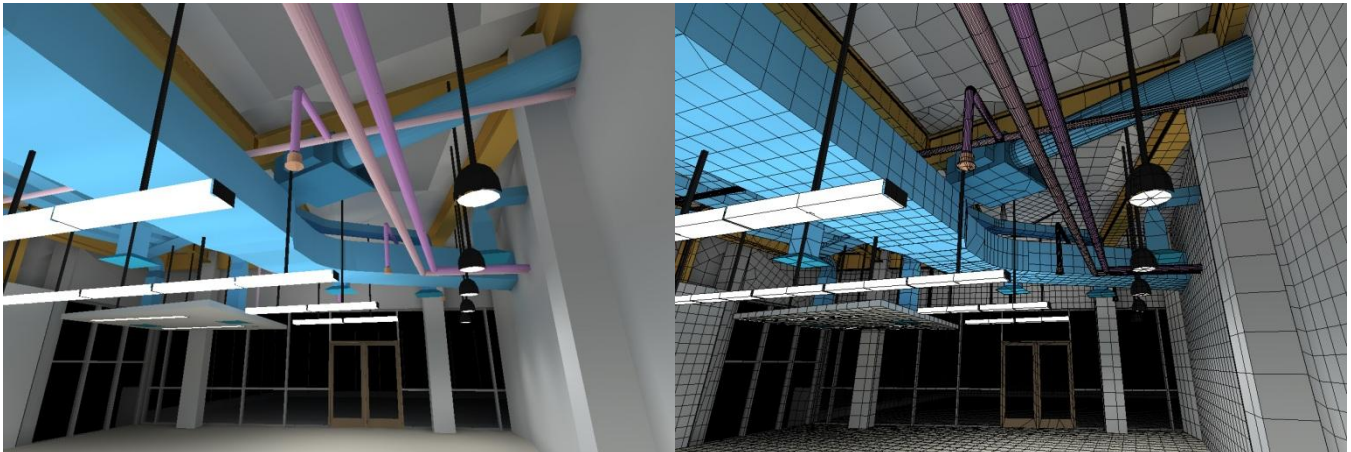
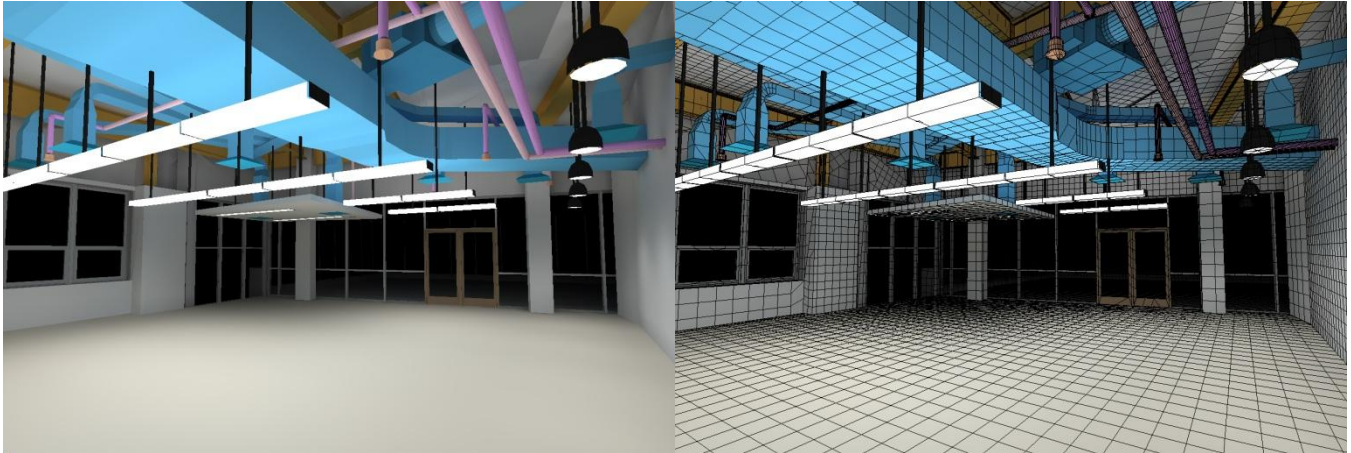


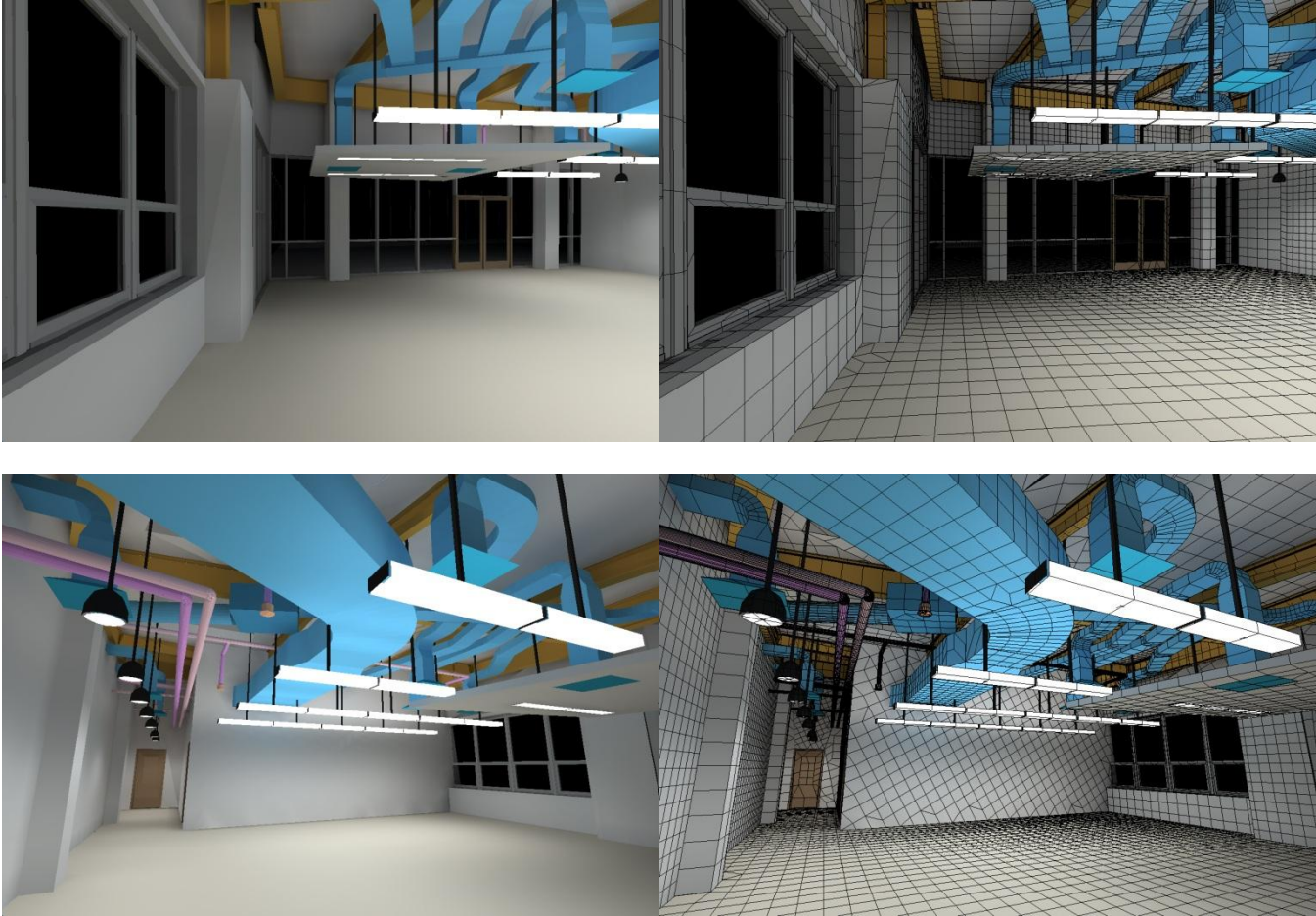




Renderings

This section shows interior renderings of the space that are intended to help give a better understanding of the feeling of the interior environment. These renderings include only electric lighting and no daylight. They are intended to show the space under the times electric light would be utilized, which would most likely be the at night. The image on the left shows the rendering; the image on the right shows the calculation mesh.





Evaluation

Summary

The high school art room design strived to integrate electric lighting, architecture, and daylighting all with the goal of creating a space that is not only efficient in design, but creates the stimulating and creative environment demanded by the tasks evident in an art room. We can conclude that the space achieves a high level of daylight integrate (see MAE breadth) and creates a stimulating and creative environment (shown in the renderings—See CM breadth for further justification). The removal of the standard acoustical ceiling grid creates an interesting environment to be in, and because of the shading system implanted (MAE breadth) glare and distraction is avoided. In general, the overall design goals for this space have been met via daylight integration to both effectively utilize daylight illuminance and also to reduce glare and distraction. The space creates an atmosphere different than the rest of the building. This room is the creative “get-away.”

ASHRAE/IESNA 90.1

Looking at the tables below, we see that the High School Art Room consumes a total of 969 Watts, which equates to a space power density of 0.80. This is significantly lower than the allowed 1.24 Watts/ft² allowed by ASHRAE 90.1.

HS ART ROOM TOTAL INPUT WATTS				
Type	Lamp	Qty	Input W	Total W
A4	(1) F32T8	14	38	532
B4	(1) F32T8	4	38	152
C4	LED	8	35	280
EX	LED	1	5	5
			Total:	969

ASHRAE/IESNA 90.1 2011		
Category	Allowable	Actual
Area (sq.ft.)	-	1208
Input Watts (W)	1498	969
Power Density (W/sqft)	1.24	0.80

Electrical

This section is dedicated to the electrical portion of the design work. Included in this section are the electrical requirements for the four lighting spaces, a coordination study and short circuit analysis, and two electrical depth topics. The first depth topic is an analysis of the electrical distribution method of the rooftop mechanical equipment which is aimed at finding a more cost effective method. The second depth topic, is an SKM analysis of the electrical distribution system which aimed to compare the AIC rating of the existing panelboards against the available short-circuit current calculated by SKM. This section of the report is organized according to the following hierarchy:

1 | Four Lighting Spaces

- a. Introduction
- b. Panelboards
- c. Electrical Information
 - i. Control Description
 - ii. Luminaire Layout and controls
 - iii. Existing Panelboard Schedules
 - iv. Existing Dimmer Schedules
 - v. Panelboard Worksheets
 - vi. Revised Panelboard Schedule
 - vii. New Dimming and wiring diagram
 - viii. Resized Panelboard feeder
 - ix. Manufacturer information

2 | Coordination Study / Short Circuit

- a. Coordination Study
- b. Short Circuit Calculations

3 | Depth Topic 1

3 | Depth Topic 2

1 | Four lighting spaces

a. Introduction

The lighting and electrical redesign will occur for the following four spaces: the Façade, Auditorium, Intermediate School (IS) Café, and High School (HS) Art room. The lighting redesign of these four spaces focuses on achieving the original design goals with as little energy consumption as possible. The goals of the faced are to be minimalistic (unobtrusive to the architecture), have a high visibility from the river, have a vandal-proof installation as it is in an urban area, and last to create a focal point at the entrance of the building as it is very small and hidden.

The auditorium, which is located in the center of the building, acts as the heart and connection point of the third floor (dedicated to the Intermediate School students) and the fourth floor (dedicated to the High School students). The goals of the lighting design in this space is to accent the architecture as a lot of time has gone into beautifully designing this space, but the lighting in this space also needs to be flexible. The space may be used for large class meetings or for performances, talent shows, or musical events – the lighting needs to be suitable for all of these uses.

The Intermediate School Café, which is the main lunchroom for the Intermediate School kids, needs to be reflective of the space usage. Analyzing the age of the students that will be using this space, it is obvious that the lighting should be fun and creative, but provide sufficient illuminance for eating.

The last space in the redesign project, the High School Art Room, is located on the fifth floor, and large potential to utilize daylighting. The space is blanketed on two walls with glazing, and faces mostly north. This means that daylighting can be utilized with minimal worries of glare. Utilizing daylight to the maximum is the main design goal of this space, but the lighting should also promote creativity and individuality, decrease distraction, and – because of my personal interest in education – have the ability to be used as a tool for lighting education.

b. panelboards

PANELBOARDS						
PANEL TAG	VOLTAGE	SYSTEM	FAÇADE	AUDITORIUM	IS CAFÉ	HS ART ROOM
1LP-A	208Y/120V, 3P, 4W	N	X			
1ELP-LS	208Y/120V, 3P, 4W	N/E	X			
5LP-A	208Y/120V, 3P, 4W	N			X	X
5ELP-LS	208Y/120V, 3P, 4W	N/E	X		X	
3LP-DIM 1	208Y/120V, 3P, 4W	N		X		
3LP-DIM 2	208Y/120V, 3P, 4W	N		X		
3ELP-DIM	208Y/120V, 3P, 4W	N/E		X		

c. electrical information

i. Control Description

Façade

The façade lighting for the Hunters Point South Intermediate School and High School is connected into the buildings time clock control system. All lighting comes on at night and comes on in the morning. No manual switching devices have been included for the façade lighting. In addition, the lighting fixtures serving the entrance and exits of the building are connected to the emergency power system, meaning that they are always on.

Auditorium

The auditorium is split into multiple zones, all with dimming capabilities. The fixtures in the space that are deemed emergency fixtures are dimmable as well and are fed from a dimming panel connected to the emergency system. These fixtures may be dimmed as desired—in the event of a power outage the control system will force them back to full output. The stage lighting is split into two zones; 4 of the 16 fixtures dedicated to emergency, the rest dimmable, general illumination stage lighting. The recessed downlights located near the entrance and exits of the space, zoned separately, are connected to the emergency system and are set to be always on at full output. The lighting over the general seating area, is split into four zone, with each row of lighting being its own zone. This gives large flexibility in the lighting in the space, allowing the lighting and illuminance levels to be altered depending on the event.

Intermediate School Cafeteria

The Intermediate School Cafeteria has a three-zone configuration with two switches per zone (one located at each door), all connected to a line-voltage occupancy sensor. All override switches are *key* switches, as to prevent the students from tampering with the lighting. The recessed linear fluorescent over the main eating tables are split into two zones, with the luminaires closest to the exterior glazing controlled separately. This allows those lights to be (manually) turned off when daylight in the space is sufficient. The recessed fluorescent wall washers over the eating benches comprise the third zone. This zone of lights (uniformly) washes the wall, while providing sufficient illuminance for eating at the benches along the wall.

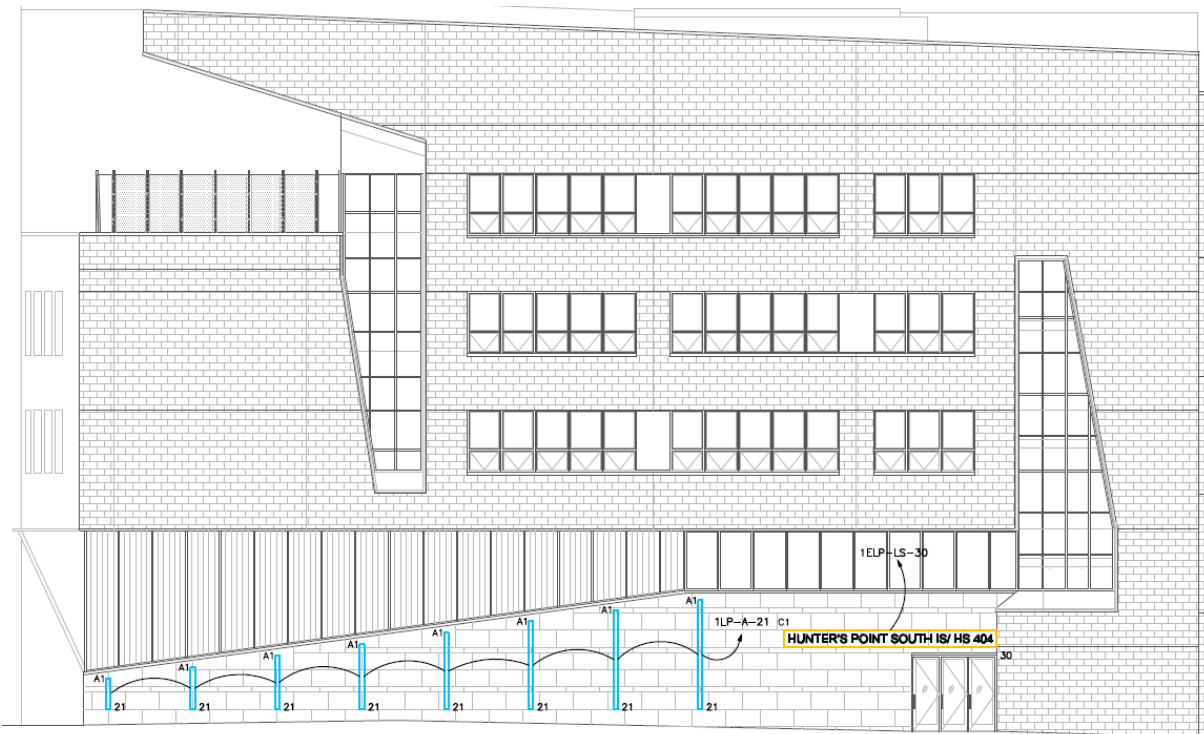
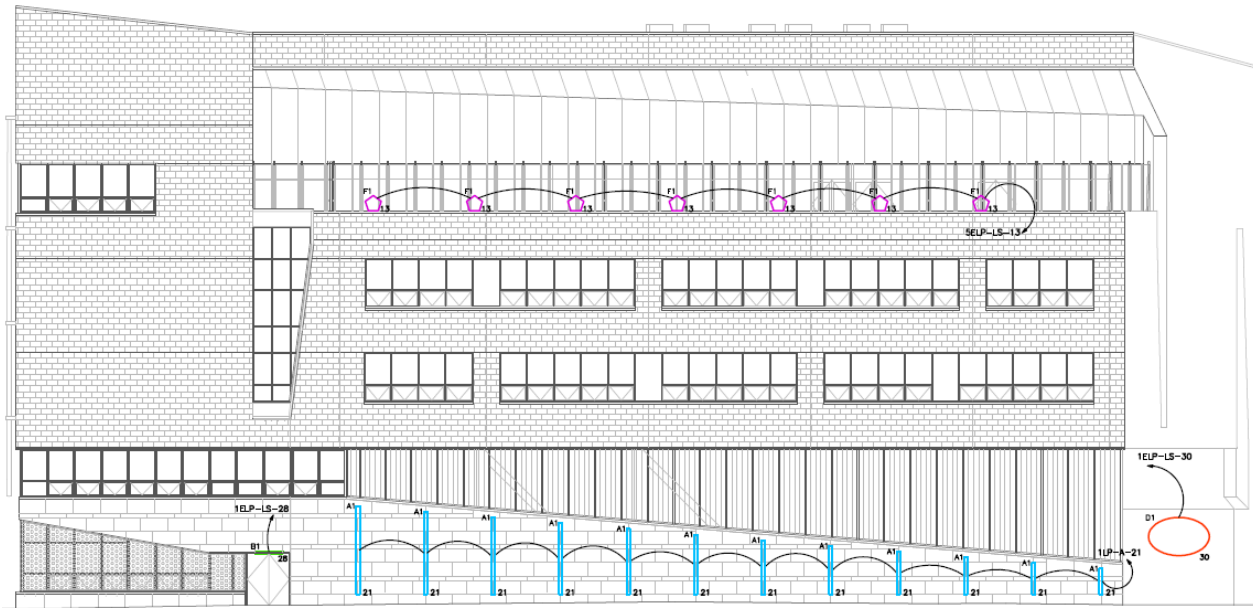
High School Art Room











The High School Art Room has a three-zone configuration with switches at two locations; a set at the entrance door to the space, and another to the rear of the teacher's desk by the whiteboard. The suspended compact fluorescent fixtures at the front of the space are on their own zone in the event that daylight provides sufficient illuminance to the rear and middle area of the space, but emphasis is desired in the front of the class; for a lecture, perhaps. The suspended linear fluorescents over the students seating area is broken into two zones. The run of fixtures nearest the east wall are zone separately as this tends to be the area that receives the least daylight and is the location of the sinks and cleaning equipment. These luminaires may be switched on if daylight does not provide sufficient illuminance levels in this area.

ii. Luminaire Layout and Controls

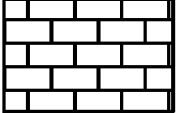
Façade

The elevations below show the layout of the luminaires for the façade lighting system. Reference the lighting fixture schedule following the elevations for information about the lighting fixtures used on the façade. To view the view the plan to scale, reference the appendices at the end of this report.

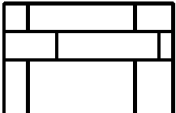


Fixture Schedule				
Type			Description	Manufacturer
A1			Recessed linear LED strip. Stainless steel luminaire housing with sealed enclosure - wet listed for exterior. 6500k white LED's. Various fixture lengths, 4W/foot.	HessAmerica
B1			Surface mounted, F32T8 direct linear fluorescent. High impact radial lense (outdoor appropriate) with tamper resistant screws. 4 foot, die-formed, gloss white (YGW) 20-gauge steel housing	Prudential Lighting
C1			Surface mounted, flexible LED strip. Super bright, white (3500K), LED's. 2.4W/ft for LED of white output.	Cooper - RSA Lighting
D1			Acrylic, 0.3 inch, surface-mounted LED lighting panel. Ellipse shaped: long radius 4'6", short radius 2'10". White (3500k) LED's. Reflective opaque white backing to maximize optical brightness	Rosco Architectural
F1			Recessed, in-ground rated, 150W PSMH floodlight. One-piece, die-cast aluminum housing, with white premium polyester powder coat paint for protection. Include top visor.	Cooper Lighting

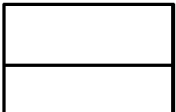
MATERIAL FINISH KEY



3-5/8" X 3-5/8" X 11-5/8"
UTILITY BRICK SET IN
ONE-THIRD RUNNING BOND



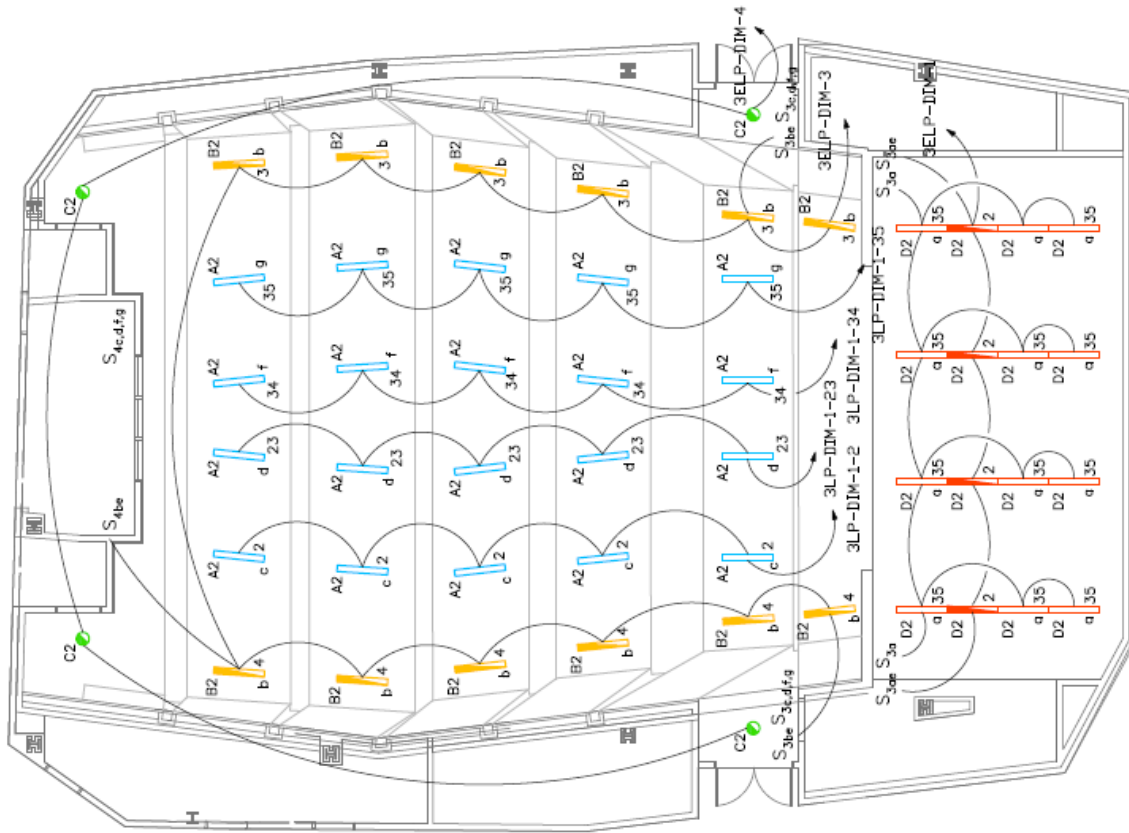
2" THICK EXTERIOR CUT STONE



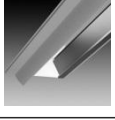







ALUMINUM COMPOSITE
PANEL

Auditorium

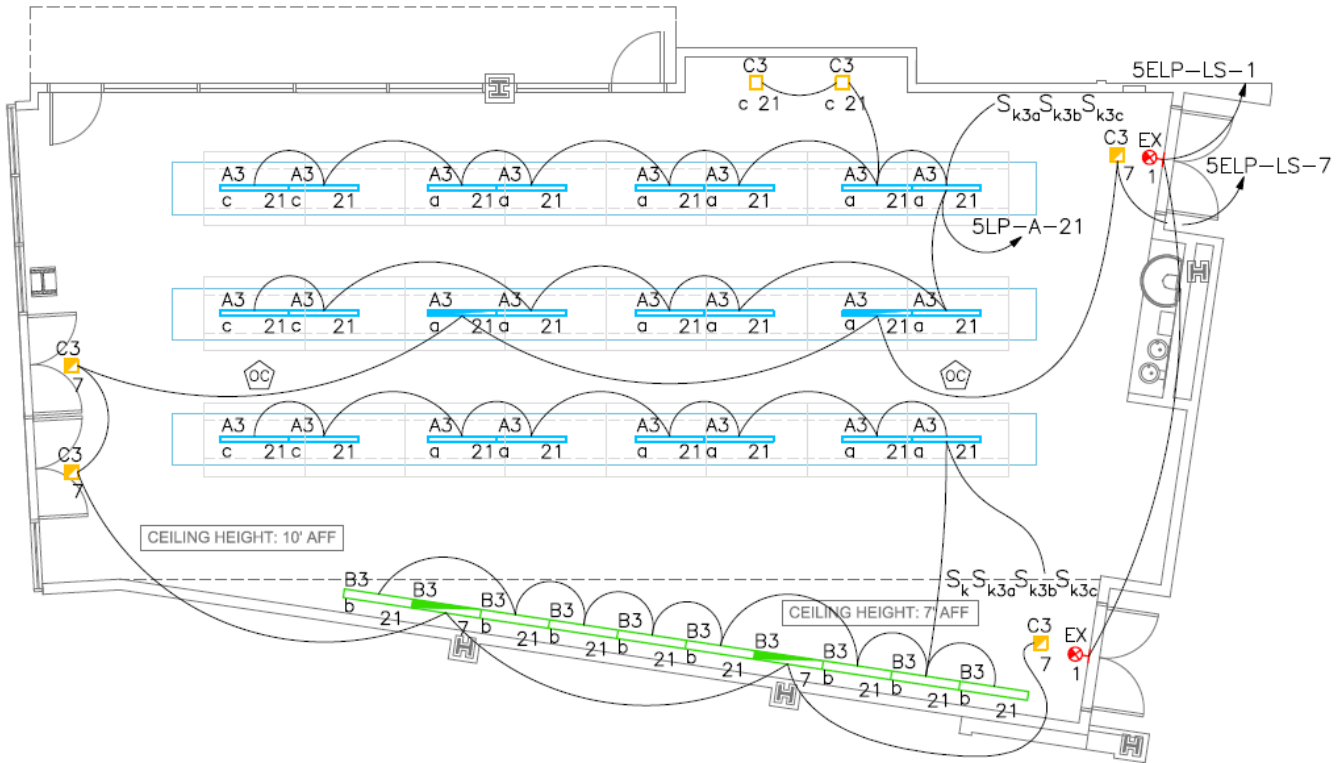
The plan below shows the layout of the luminaires as well as the locations of the switches. Reference the lighting fixture schedule following the plan for information about the lighting fixtures used in the space. To view the plan to scale, reference Appendix D at the end of this report. Following the fixture schedule is the occupancy coverage pattern for the space.











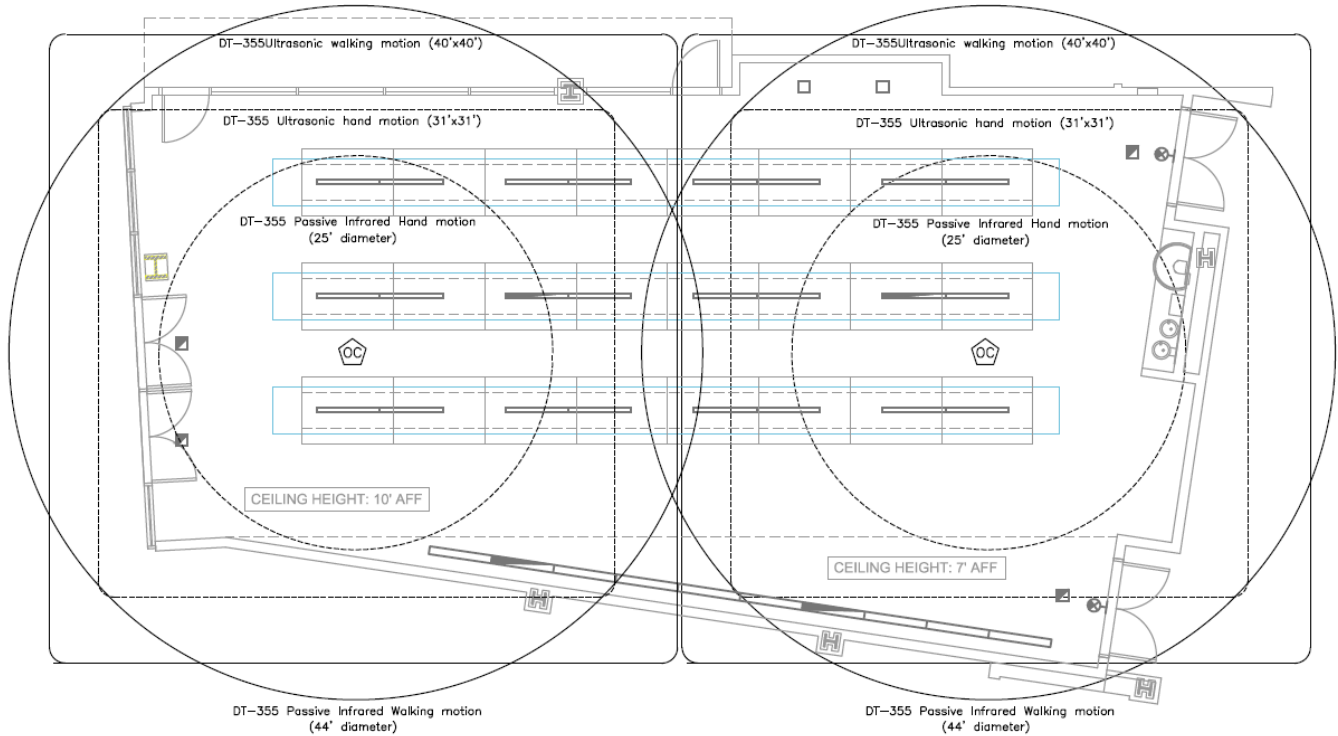
Fixture Schedule				
Type			Description	Manufacturer
A2			Recessed linear fluorescent with flush .07" thick acrylic lens with opal satin finish. 22 ga. steel reflectors with high reflectance white powder coat. Matte White finish	Focal Point
B2			Recessed linear fluorescent wall-washer with flush .07" thick acrylic lens with opal satin finish. 22 ga. steel reflectors with high reflectance white powder coat. Matte White finish	Focal Point
C2			Single-lamp, recessed compact fluorescent downlight with 7 3/8" aperture. Matte white finished flange with 16 ga. aluminum, wide distribution reflector.	Lightolier
D2			Single-lamp, suspended linear T8 linear fluorescent downlight. 4' length bony of formed and welded die-formed 20-gauge steel. Gloss white (YGW) polyester power paint finish.	Prudential

IS Cafeteria

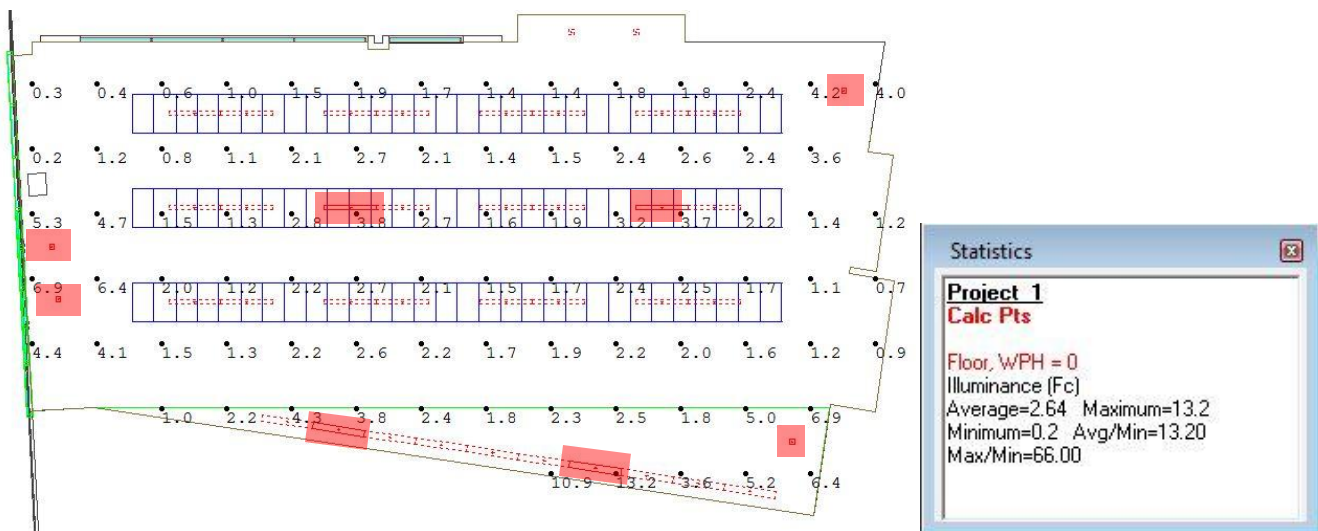
The plan below shows the layout of the luminaires as well as the locations of the switches. Reference the lighting fixture schedule following the plan for information about the lighting fixtures used in the space. To view the plan to scale, reference Appendix D at the end of this report. Following the fixture schedule is the occupancy coverage pattern for the space.



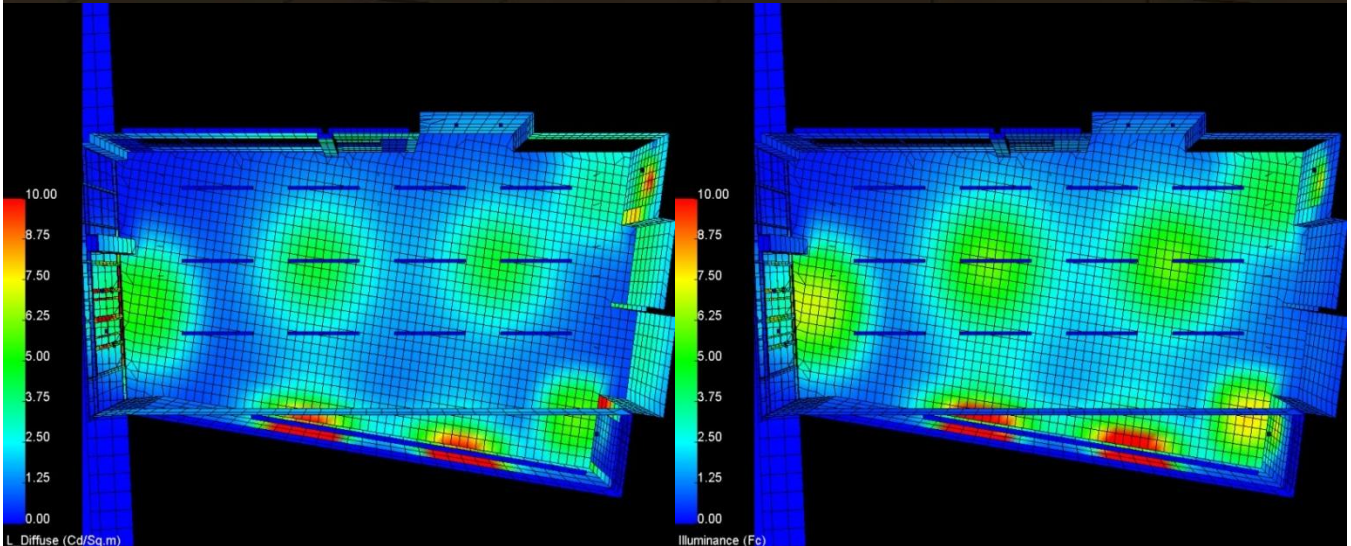
Fixture Schedule				
Type	Description			Manufacturer
A3			Recessed linear fluorescent with flush .07" thick acrylic lens with opal satin finish. 22 ga. steel reflectors with high reflectance white powder coat. Matte White finish	Focal Point
B3			Recessed linear fluorescent wall washer. Housing and flange trim are die-formed, 20 ga. Steel, with gloss white finish. Semi-specular reflector	Peerless
C3			Recess 4.5"x4.5" square LED downlight. Matte white flange and reflector finish.	Lightolier
EX			Wall Mounted, single-sided exit sign. AC only operation with RED lettering on clear panel. Matte white finish on housing. 8" letters, 1" stroke	Mule Lighting



The transparent red boxes on the plan below indicate the emergency lighting fixture in the space. All of these fixtures are on a Normal/Emergency system, and as such, are on all the time. They are not connected to the occupancy sensors in the space, not the wall switches. The emergency lighting performance meets the average and minimum values as required by IBC. It does not, however, meet the uniformity ratio of 40. This is easily fixed by adding an additional luminaire where the values are a bit low, or removing one where the values are a bit high (i.e. the south wall). An interior rendering and pseudo diagrams (illuminance and luminance) of the space during the emergency lighting condition are presented on the next page.

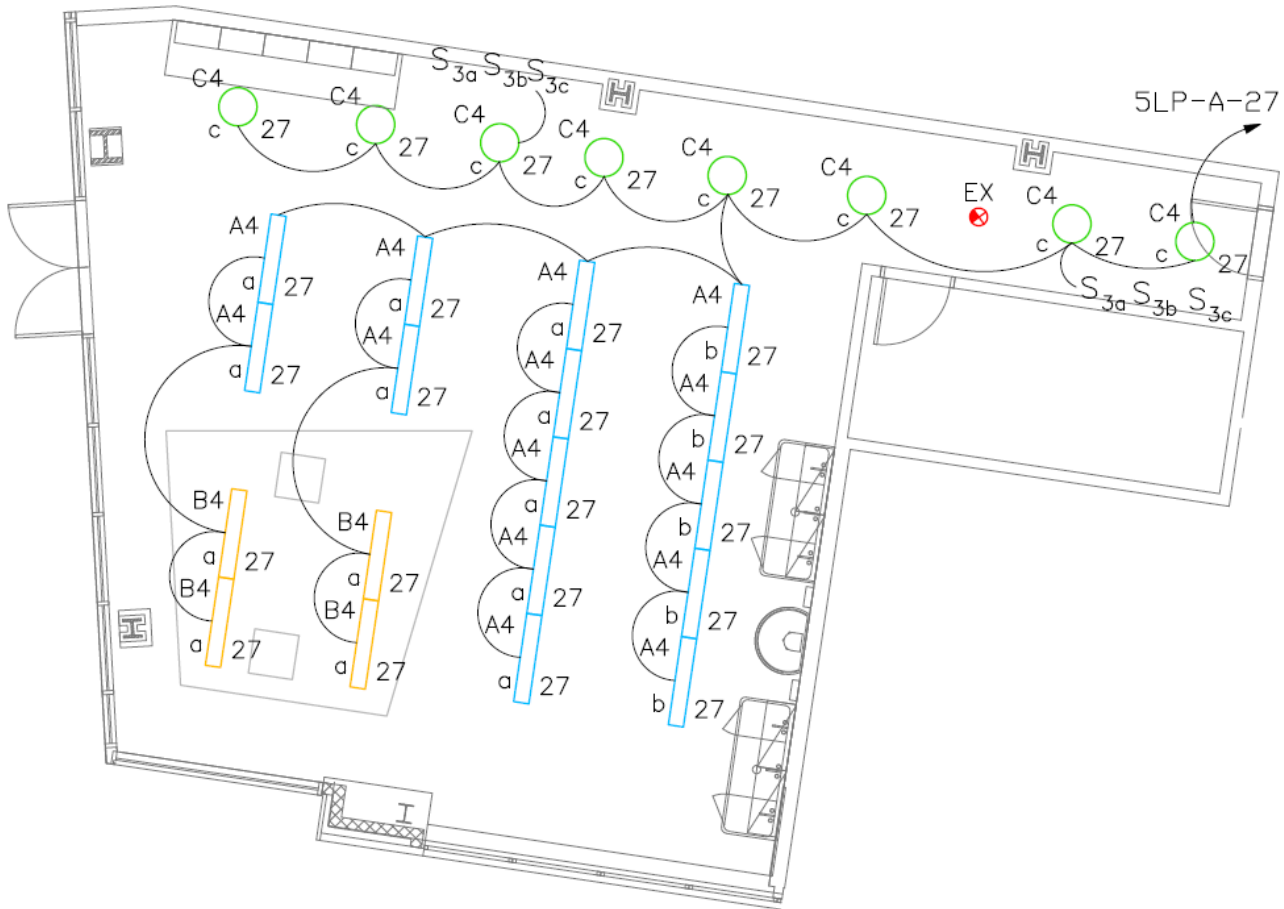










The images below show the interior environment under emergency lighting conditions (furniture removed)



High School Art Room

The plan below shows the layout of the luminaires as well as the locations of the switches for the High School Art Room. Reference the lighting fixture schedule following the plan for information about the lighting fixtures used in the space. To view the view the plan to scale, reference the Appendix D at the end of this report.



Fixture Schedule				
Type	Description			Manufacturer
A4			Single-lamp, Suspended linear fluorescent semi-indirect pendant with die-formed specular reflector. Reflector 95% reflective. Aluminum semispecular parabolic louver.	Peerless
B4			Single-lamp, recessed linear fluorescent semi-indirect pendant with die-formed specular reflector. Reflector 95% reflective. Aluminum semispecular parabolic louver.	Peerless
C4			Suspended, 26W 3500k compact fluorescent, downlight. 14 ga. Single-piece precision-spun aluminum. 14 ga. Anodized aluminum reflector with diffuse satin matte surface.	Focal Point
EX			Ceiling-Mounted, single-sided exit sign. AC only operation with RED lettering on clear panel. Matte white finish on housing. 8" letters, 1" stroke	Mule Lighting

iii. Existing Panelboard Schedules

Below are the existing panelboards (Normal and Normal/Emergency) that serve the Intermediate School Caf . They have been recreated in excel for clarity, and are presented on the next two pages. Circuits serving each space are appropriately colored with each spaces assigned color (see table in section 1b).

JOB:								PANEL CODE--		1(120/208V)	
PANEL:		5LP-A								2(277/480V)	
PANEL CODE:		1								3(265/460V)	
PHASE:		3						LOCATION:		5th Fl Elec Closet	
WIRE:		4						MTD:		Surface	
MAINS AMP:		100						MAIN CB AMP:		100	
								AIC:		22000	
CIRCUIT		LOAD		PHASES			LOAD		CIRCUIT		
NO	BKR	DESIGNATION	VA	A	B	C	VA	DESIGNATION	BKR	NO	
1	20	RM 505, 511, Ltg	1200	2100			900	Corridor , Itg	20	2	
3	20	RM 513, Ltg	700		1100		400	RM 539,541,545, Ltg	20	4	
5	20	Spare				400	400	Toilets, Ltg	20	6	
7	20	RM 526, Ltg	1100	2000			900	RM 519, Itg	20	8	
9	20	RM 519, Ltg	1300		1900		600	RM 523, Itg	20	10	
11	20	RM 521,523, Ltg	1300			1900	600	RM 525, Itg	20	12	
13	20	RM 525, Ltg	1200	1200				Spare	20	14	
15	20	RM 518,522, 524,Ltg	1100		1100			Spare	20	16	
17	20	RM 506,508,534, Ltg	800			800		Spare	20	18	
19	20	RM 534,536,538, Ltg	800	800				Spare	20	20	
21	20	RM 541,546, Ltg	800		1700		900	Roof MER, Itg	20	22	
23	20	RM 534, Ltg	400			1000	600	Roof Exterior, Itg	20	24	
25	20	Kitchen 534, Ltg	800	1400			600	Roof Exterior, Itg	20	26	
27	20	RM 552, Ltg	1300		1900		600	Roof Exterior, Itg	20	28	
29	20	RM 547,549,551, Ltg	1000			1000		Spare	20	30	
31	20	Spare		0				Spare	20	32	
33	20	Spare			0			Spare	20	34	
35	20	Spare				0		Spare	20	36	
TOTAL				7500	7700	5100	TOT. KVA	20			
							TOT. AMP	56			
DEM. DECIMAL							1	DEM.KVA	22		
SPARE DECIMAL							0.1	DEM.AMP	62		

JOB:								PANEL CODE--		1(120/208V)	
PANEL:		5ELP-LS								2(277/480V)	
PANEL CODE:		1								3(265/460V)	
PHASE:		3						LOCATION:		5th Fl Elec Closet	
WIRE:		4						MTD:		Surface	
MAINS AMP:		100						MAIN CB AMP:		60	
								AIC:		22000	
CIRCUIT		LOAD		PHASES			LOAD		CIRCUIT		
NO	BKR	DESIGNATION	VA	A	B	C	VA	DESIGNATION	BKR	NO	
1	20	5th fl exit signs	300	900			600	RM 601, 603, 604	20	2	
3	20	5th fl Kitchen em Itg	700		700			Spare	20	4	
5	20	5th fl HS Cafe em Itg	800			800		Spare	20	6	
7	20	5th fl IS Cafe em Itg	500	500				Spare	20	8	
9	20	RM 514, 535	300		300			Spare	20	10	
11	20	5th fl corridor em Itg	800			800		Spare	20	12	
13	20	Terrace Itg	1200	1200				Spare	20	14	
15	20	RM 517	400		400			Spare	20	16	
17	20	Spare				0		Spare	20	18	
TOTAL				2600	1400	1600	TOT. KVA	6			
							TOT. AMP	16			
DEM. DECIMAL							1	DEM.KVA	14		
SPARE DECIMAL							1.5	DEM.AMP	39		

The panelboard below is that which serves normal power to the lighting in the Intermediate School Cafeteria and High School Art Room. All existing lighting for the Intermediate school cafeteria are located on circuit 21 (highlighted in blue below), and all lighting fixtures for the High School Art Room are located on circuit 27 (highlighted in orange).

PANELBOARD SCHEDULE											
Panel:		5LP-A		BUS:		100A		Voltage:		208/120	
Location:		5TH FLR. ELEC. CLOSET		MCB:		100A		Phase:		3P	
Mounting:		SURFACE		AIC:		22,000		Wire:		4W	
CKT NO	CB	LOAD DESCRIPTION	Load VA			LOAD DESCRIPTION	CB	CKT NO			
			A	B	C						
1	20/1	RM 505,511, LTG	1200	900		CORRIDOR, LTG	20/1	2			
3	20/1	RM 513, LTG		700	400	RM 539, 541, 545, LTG	20/1	4			
5	20/1	SPARE			0	400	TOILETS, LTG	20/1	6		
7	20/1	RM 526, LTG	1100	900		RM 519, LTG	20/1	8			
9	20/1	RM 519, LTG		1300	600	RM 523, LTG	20/1	10			
11	20/1	RM 521,523, LTG			1300	600	RM 535, LTG	20/1	12		
13	20/1	RM 525, LTG	1200	*			SPARE	20/1	14		
15	20/1	RM 518, 522, 524, LTG		1100	*		SPARE	20/1	16		
17	20/1	RM 506, 508, 534, LTG			800	*	SPARE	20/1	18		
19	20/1	RM 534, 536, 538, LTG	800	*			SPARE	20/1	20		
21	20/1	RM 546, LTG		800	900		ROOF MER, LTG	20/1	22		
23	20/1	RM 543, LTG			400	600	ROOF EXTERIOR, LTG	20/1	24		
25	20/1	KITCHEN 534, LTG	800	600			ROOF EXTERIOR, LTG	20/1	26		
27	20/1	RM 552, LTG		1300	600		ROOF EXTERIOR, LTG	20/1	28		
29	20/1	RM 547, 549, 551, LTG			1000	*	SPARE	20/1	30		
31	20/1	SPARE	*	*			SPARE	20/1	32		
33	20/1	SPARE		*	*		SPARE	20/1	34		
35	20/1	SPARE			*	*	SPARE	20/1	36		
VA/PHASE			7500	7700	5100						
TOTAL [VA]			20300								
TOTAL [A]			56.39								

The panelboard below is that which serves all emergency fixtures for the 5th floor, which includes both the Intermediate School Cafeteria, and the High School Art Room. Circuit 7 – highlighted in blue—contains all emergency lighting fixture in the IS Cafeteria. Circuit 1 – highlighted with a gradient that represents both the Intermediate School Café and the High School Art Room – contains all exit signs for the fifth floor. All exit signs are considered existing to remain, and as such, this circuit will remain unchanged. It is highlighted here for the purposes of showing its consideration. Circuit 13, highlighted in red, contains all lighting on the outdoor roof terrace on the fifth floor.

PANELBOARD SCHEDULE											
Panel:		5ELP-LS		BUS:		100A		Voltage:		208/120	
Location:		5TH FLR. ELEC. CLOSET		MCB:		60A		Phase:		3P	
Mounting:		SURFACE		AIC:		22,000		Wire:		4W	
CKT NO	CB	LOAD DESCRIPTION	Load VA				LOAD DESCRIPTION	CB	CKT NO		
			A	B	C						
1	20/1	5TH FL EXIT SIGNS	300	600			RM 601, 603, 604	20/1	2		
3	20/1	5TH FL KITCHEN EM LTG		700	*		SPARE	20/1	4		
5	20/1	5TH FL HS CAFÉ EM LTG			800	*	SPARE	20/1	6		
7	20/1	5TH FL IS CAFÉ EM LTG	500	*			SPARE	20/1	8		
9	20/1	RM 514, 535		300	*		SPARE	20/1	10		
11	20/1	5TH FL CORRIDOR EM LTG			800	*	SPARE	20/1	12		
13	20/1	TERRACE LTG	1200	*			SPARE	20/1	14		
15	20/1	RM 517		400	*		SPARE	20/1	16		
17	20/1	SPARE			*	*	SPARE	20/1	18		
VA/PHASE			2600	1400	1600						
TOTAL [VA]			5600								
TOTAL [A]			15.56								

The following panelboards, 1LP-A and 1ELP-LS, contain all exterior façade lighting. Circuit 21 and 23 of panelboard 1LP-A serves the existing lighting solution which includes step lights recessed into the stone around the perimeter of the building. Circuits 28 and 30 of panelboard 1ELP-LS contain the lighting on the façade of the building near the entrance door and (two) exits of the building.

The first two panelboards shown were snapshotted from my drawings. The second two are reproductions using my own excel panelboard template.

JOB:						PANEL CODE-		1(120/208V)	
PANEL:						PANEL CODE-		2(277/480V)	
PANEL CODE:						PANEL CODE-		3(265/460V)	
PHASE:						LOCATION:		1st Fl Elec Closet	
WIRE:						MTD:		Surface	
MAINS AMP:						AIC:		22000	
MAIN CB AMP:						100			

CIRCUIT		LOAD	LOAD	PHASES			LOAD	LOAD	CIRCUIT	
NO	BKR	DESIGNATION	VA	A	B	C	VA	DESIGNATION	BKR	NO
1	20	RM 101, 103, Ltg	800	1900			1100	Corridor, Ltg	20	2
3	20	RM 101, 103, Ltg	800		1900		1100	Corridor, Ltg	20	4
5	20	RM 105, Ltg	1200			2300	1100	Stair A	20	6
7	20	RM 102, 134, 106, Ltg	900	2000			1100	Stair B	20	8
9	20	RM 107-109, Ltg	700		1500		800	2nd fl stair C	20	10
11	20	RM 134, 144, Ltg	800			1200	400	Toilets 133	20	12
13	20	RM 145, 141, Ltg	800	800				Spare	20	14
15	20	RM 113-115, Ltg	900		900			Spare	20	16
17	20	RM 121,123,126, Ltg	800			800		Spare	20	18
19	20	RM 118-122, Ltg	900	900				Spare	20	20
21	20	Exterior Itg	900		900			Spare	20	22
23	20	Exterior Itg	900			900		Spare	20	24
25	20	Spare		0				Spare	20	26
27	20	Spare			0			Spare	20	28
29	20	Spare				0		Spare	20	30
TOTAL				5600	5200	5200	TOT. KVA	16		
							TOT. AMP	44		
DEM. DECIMAL							DEM.KVA	18		
SPARE DECIMAL							DEM.AMP	49		

JOB:						PANEL CODE-		1(120/208V)	
PANEL:						PANEL CODE-		2(277/480V)	
PANEL CODE:						PANEL CODE-		3(265/460V)	
PHASE:						LOCATION:		1st Fl Elec Closet	
WIRE:						MTD:		Surface	
MAINS AMP:						AIC:		22000	
MAIN CB AMP:						100			

CIRCUIT		LOAD	LOAD	PHASES			LOAD	LOAD	CIRCUIT	
NO	BKR	DESIGNATION	VA	A	B	C	VA	DESIGNATION	BKR	NO
1	20	1st fl corridor em Itg	1100	1400			300	2nd fl exit signs	20	2
3	20	1st fl corridor em Itg	600		1400		800	2nd fl corridor em Itg	20	4
5	20	1st fl exit signs	300			1300	1000	Library 205	20	6
7	20	1st fl gym em Itg	600	1100			500	RM 230,240	20	8
9	20	RM113,14,17,23,19,33	1100		1300		200	RM 212, 233	20	10
11	20	RM 134, 144	600			1100	500	RM 213	20	12
13	20	Stair A em Itg	1500	1500				Spare	20	14
15	20	Stair B em Itg	1500		1500			Spare	20	16
17	20	Stair C em Itg	800			800		Spare	20	18
19	20	Gym ceiling em Itg	1000	1000				Spare	20	20
21	20	Gym ceiling em Itg	1000		1000			Spare	20	22
23	20	Gym ceiling em Itg	1000			1000		Spare	20	24
25	20	Gym ceiling em Itg	1000	1000				Spare	20	26
27	20	1st fl gym em Itg	600		800		200	Exit door	20	28
29	20	Spare				300	300	Entrance	20	30
TOTAL				6000	6000	4500	TOT. KVA	17		
							TOT. AMP	46		
DEM. DECIMAL							DEM.KVA	23		
SPARE DECIMAL							DEM.AMP	64		

PANELBOARD SCHEDULE											
Panel:		1LP-A		BUS:		100A		Voltage:		208/120	
Location:		1ST FLR ELEC CLOSET		MCB:		100A		Phase:		3P	
Mounting:		SURFACE		AIC:		22,000		Wire:		4W	
CKT NO	CB	LOAD DESCRIPTION	Load VA				LOAD DESCRIPTION	CB	CKT NO		
			A	B	C						
1	20/1	RM 101, 103, LTG	800	1100			CORRIDOR, LTG	20/1	2		
3	20/1	RM 101, 103, LTG		800	1100		CORRIDOR, LTG	20/1	4		
5	20/1	RM 105, LTG				1200	1100	STAIR A	20/1	6	
7	20/1	RM 102, 134, 106, LTG	900	1100				STAIR B	20/1	8	
9	20/1	RM 107-109 LTG		700	800			2ND FL STAIR C	20/1	10	
11	20/1	RM 134, 144, LTG				800	400	TOILETS 133	20/1	12	
13	20/1	RM 145, 141, LTG	800	*				SPARE	20/1	14	
15	20/1	RM 113-115 LTG		900	*			SPARE	20/1	16	
17	20/1	RM 121,123,126, LTG				800	*	SPARE	20/1	18	
19	20/1	RM 118-122, LTG	900	*				SPARE	20/1	20	
21	20/1	EXTERIOR LTG		900	*			SPARE	20/1	22	
23	20/1	EXTERIOR LTG				900	*	SPARE	20/1	24	
25	20/1	SPARE	*	*				SPARE	20/1	26	
27	20/1	SPARE		*	*			SPARE	20/1	28	
29	20/1	SPARE				*	*	SPARE	20/1	30	
VA/PHASE			5600	5200	5200						
TOTAL [VA]			16000								
TOTAL [A]			44.44								

PANELBOARD SCHEDULE									
Panel: <u>1ERP-LS</u>			BUS: <u>100A</u>			Voltage: <u>208/120</u>			
Location: <u>1ST FLR ELEC CLOSET</u>			MCB: <u>100A</u>			Phase: <u>3P</u>			
Mounting: <u>SURFACE</u>			AIC: <u>22,000</u>			Wire: <u>4W</u>			
CKT NO	CB	LOAD DESCRIPTION	Load VA			LOAD DESCRIPTION	CB	CKT NO	
			A	B	C				
1	20/1	1ST FL CORRDR EM LTG	1100	300		2ND FL EXIT SIGNS	20/1	2	
3	20/1	1ST FL CORRDR EM LTG		600	800	2ND FL CORRDR EM LTG	20/1	4	
5	20/1	1ST FL EXIT SIGNS			300	1000	LIBRARY 205	20/1	6
7	20/1	1ST FL GYM EM LTG	600	500			RM 230,240	20/1	8
9	20/1	RM 133,14,17,23,19,33		1100	200		RM 212,233	20/1	10
11	20/1	RM 134,144			600	500	RM 213	20/1	12
13	20/1	STAIR A EM LTG	1500	*			SPARE	20/1	14
15	20/1	STAIR B EM LTG		1500	*		SPARE	20/1	16
17	20/1	STAIR C EM LTG			800	*	SPARE	20/1	18
19	20/1	GYM CEILING EM LTG	1000	*			SPARE	20/1	20
21	20/1	GYM CEILING EM LTG		1000	*		SPARE	20/1	22
23	20/1	GYM CEILING EM LTG			1000	*	SPARE	20/1	24
25	20/1	GYM CEILING EM LTG	1000	*			SPARE	20/1	26
27	20/1	1ST FL GYM EM LTG		600	200		EXIT DOOR	20/1	28
29	20/1	SPARE			0	300	ENTRANCE	20/1	30
VA/PHASE			6000	6000	4500				
TOTAL [VA]			16500						
TOTAL [A]			45.83						

iv. Existing dimmer schedules

The existing lighting design for the Façade does not have dimming capabilities.

The existing lighting design for the IS Cafeteria does not have dimming capabilities.

The existing lighting design for the High School Art Room does not have dimming capabilities.

The panels following on the previous pages are that which feed the lighting in the auditorium. These panels, all with dimming capabilities, are connected to a control system that allows lighting to be zoned and dimmed as desired by the lighting consultant. Panel 3ELP-LS is the emergency dimming lighting panel for the space and is the panel that all auditorium emergency lighting is connected to. This panel does not include emergency lighting for other spaces in the building. 3LP-DIM-1 and 3LP-DIM-2 are normal power dimming panels, and power all lighting fixtures in the auditorium that are not deemed emergency. These panels do not include lighting outside of the auditorium space. Panel 3LP-DIM-2 is dedicated entirely to theatrical lighting, which for the sake of complexity and knowledge, has been left existing-to-remain. As such, panel 3LP-DIM-2 has not been altered or changed in any way, and is only shown in this section for the purpose of noting its use in the space. The circuits highlighted on the following panelboards (in green) are that of general purpose lighting only, i.e. non-theatrical lighting fixtures.

PANEL:		3ELP-DIM		DIMMING PANEL									
VOLTAGE:		208										Location: Auditorium	
PHASE:		3										Surface	
WIRE:		4+G										AIC: 22000	
MAINS AMP:		100		MAIN		C.B.		None					
CIRCUIT		CONTROL		FIXTURE		LAMP		WALL STATION	PHASE (W)			Remark	
NO	BKR	ZONE	TYPE	QTY	QTY	(W)	TYPE		A	B	C		
1	20	Note 2	TN	48	1	5	LED	5d/Skd	240			Step Lits Via Drivers	
2	20	On	Exit	5	1	20	LED			100			
3	20	Note 2	TM	12	2	35	Flure	5a/Ska			840		
4	20	Note 2	TM	8	2	32	Flure	5b/Skb	512				
5	20	Note 2	TF-1	5	1	50	Flure	5f/Skf		250			
6	20	Note 2	TL	18	1	35	Flure	5g/Skg			630	Stage	
7	20	Note 2	TN	12	1	5	LED	5e/Ske	60			Step Lits Via Drivers	
8	20	ON	TT	2	2	35	Flure	5c		140			
9	20	Note 2	TN	15	1	5	LED				75		
10	20	Spare							0				
11	20	Spare								0			
12	20	Spare									0		
NOTES:								KVA / PHASE	812	490	1545		
1. REFER TO FIXTURE SPECIFICATION FOR LAMP TYPE.								AMP / PHASE	2	1	4		
2. TO BE DETERMINED BY THE LIGHTING CONSULTANT.								TOTAL KVA	3				
								TOTAL AMP	8				
								DEM.	1				
								SPARE	4				
								DEM KVA	14				
								DEM AMP	40				

JOB:												
PANEL: 3LP-DIM 1 DIMMING PANEL												
VOLTAGE: 208												
PHASE: 3												
WIRE: 4-C												
MAINS AMP: 200												
Location: Auditorium/Stage Surface 22000												
MTD: None												
NC:												
NO	CIRCUIT	BKR	CONTROL ZONE	FIXTURE		LAMP		WALL STATION	PHASE (W)			Remark
				TYPE	QTY	QTY	(W)		TYPE	A	B	
1	20			TM	8	2	35	Sa/Ska	560			
2	20			TM	4	2	35	Sb/Skb		280		
3	20			TTE	1	1	1500				1500	
4	20			TTE	1	1	1500		1500			
5	20			TTE	1	1	1500			1500		
6	20			TTE	1	1	1500				1500	
7	20			TTE	1	1	1500		1500			
8	20			TTE	1	1	1500			1500		
9	20			TTE	1	1	1500				1500	
10	20			TTE	1	1	1500		1500			
11	20			TTE	1	1	1500			1500		
12	20			TTE	1	1	1500				1500	
13	20			TTE	1	1	1500		1500			
14	20			TTE	1	1	1500			1500		
15	20			TTE	1	1	1500				1500	
16	20			TTE	1	1	1500		1500			
17	20			TTE	1	1	1500			1500		
18	20			TTE	1	1	1500				1500	
19	20			TTH	2	1	750		1500			
20	20			TTH	2	1	750			1500		
21	20			TTH	2	1	750				1500	
22	20			TTH	2	1	750		1500			
23	20			TR	32	1	20	LV	Sc/Skc	640		
24	20			TAA	16	1	50				800	Projection room
25	20			TAA	16	1	50		800			Projection room
26	20			TTD	1	1	1500			1500		Stage floor
27	20			TTD	1	1	1500				1500	Stage floor
28	20			TTD	1	1	1500		1500			Stage floor
29	20			TTD	1	1	1500			1500		Stage floor
30	20			TTD	1	1	1500				1500	Stage floor
31	20			TTD	1	1	1500		1500			Stage floor
32	20			TTD	1	1	1500			1500		Stage floor
33	20			TTD	1	1	1500				1500	Stage floor
34	20			TR	32	1	20	LV	Sc/Skc	640		
35	20			Spare						0		
36	20			Spare							0	
37	20			Spare					0			
38	20			Spare						0		
39	20			Spare							0	
40	20			Spare					0			
41	20			Spare						0		
42	20			Spare							0	
43	20			Spare					0			
44	20			Spare						0		
45	20			Spare							0	
46	20			Spare					0			
47	20			Spare						0		
48	20			Spare							0	

NOTES:	KVA / PHASE	15500	14420	15800
1. REFER TO FIXTURE SPECIFICATION FOR LAMP TYPE.	AMP / PHASE	43	40	44
2. THE CONTROL ZONE TO BE DETERMINED BY THE LIGHTING CONSULTANT.	TOTAL KVA	46		
	TOTAL AMP	127		
	DEM.	1		

JOB:													
PANEL: 3LP-DIM 2 DIMMING PANEL													
VOLTAGE: 208													
PHASE: 3													
WIRE: 4-G													
MANS AMP: 200													
Location: Auditorium/Stage													
MTD: Surface													
AIC: 22000													
WAIN C.B. None													
CIRCUIT		CONTROL		FIXTURE		LAMP		WALL		PHASE (W)			Remark
NO	BKR	ZONE	TYPE	QTY	QTY	(W)	TYPE	STATION	A	B	C		
1	20		TTA	1	1	1500			1500			Stage	
2	20		TTA	1	1	1500				1500		Stage	
3	20		TTA	1	1	1500					1500	Stage	
4	20		TTA	1	1	1500			1500			Stage	
5	20		TTA	1	1	1500				1500		Stage	
6	20		TTA	1	1	1500					1500	Stage	
7	20		TTA	1	1	1500			1500			Stage	
8	20		TTA	1	1	1500				1500		Stage	
9	20		TTA	1	1	1500					1500	Stage	
10	20		TTA	1	1	1500			1500			Stage	
11	20		TTA	1	1	1500				1500		Stage	
12	20		TTA	1	1	1500					1500	Stage	
13	20		TTA	1	1	1500			1500			Stage	
14	20		TTA	1	1	1500				1500		Stage	
15	20		TTA	1	1	1500					1500	Stage	
16	20		TTA	1	1	1500			1500			Stage	
17	20		TTA	1	1	1500				1500		Stage	
18	20		TTA	1	1	1500					1500	Stage	
19	20		TTA	1	1	1500			1500			Stage	
20	20		TTA	1	1	1500				1500		Stage	
21	20		TTA	1	1	1500					1500	Stage	
22	20		TTA	1	1	1500			1500			Stage	
23	20		TTA	1	1	1500				1500		Stage	
24	20		TTA	1	1	1500					1500	Stage	
25	20		TTA	1	1	1500			1500			Stage	
26	20		TTA	1	1	1500				1500		Stage	
27	20		TTA	1	1	1500					1500	Stage	
28	20		TTA	1	1	1500			1500			Stage	
29	20		TTA	1	1	1500				1500		Stage	
30	20		TTA	1	1	1500					1500	Stage	
31	20		TTA	1	1	1500			1500			Stage	
32	20		TTA	1	1	1500				1500		Stage	
33	20		TTC	1	3	500					1500	Stage Floor	
34	20		TTC	1	3	500			1500			Stage Floor	
35	20		TTC	1	3	500				1500		Stage Floor	
36	20		TTC	1	3	500					1500	Stage Floor	
37	20		TTC	1	3	500			1500			Stage Floor	
38	20		TTC	1	3	500				1500		Stage Floor	
39	20		TTC	1	3	500					1500	Stage Floor	
40	20		TTC	1	3	500			1500			Stage Floor	
41	20		Spare							0			
42	20		Spare								0		
43	20		Spare						0				
44	20		Spare							0			
45	20		Spare								0		
46	20		Spare						0				
47	20		Spare							0			
48	20		Spare								0		

NOTES:	KVA / PHASE	21000	19500	19500
1. REFER TO FIXTURE SPECIFICATION FOR LAMP TYPE.	AMP / PHASE	58	54	54
2. TO BE DETERMINED BY THE LIGHTING CONSULTANT.	TOTAL KVA	60		
	TOTAL AMP	167		
	DEM.	0.8		

The panels to follow are simply recreations in excel of the existing panelboards. They are shown for clarity as they are more easily readable than those taken from the drawings.

DIMMER PANELBOARD SCHEDULE											
Panel: <u>3ELP-DIM</u>				BUS: <u>200A</u>				Voltage: <u>208/120</u>			
Location: <u>AUDITORIUM</u>				MCB: <u>-</u>				Phase: <u>3P</u>			
Mounting: <u>SURFACE</u>				AIC: <u>22,000</u>				Wire: <u>4W</u>			
CIRCUIT		CONTROL ZONE	FIXTURE		LAMP			PHASE (W)			REMARKS
NO	BKR		TYPE	QTY	QTY	W	TYPE	A	B	C	
1	20/1	NOTE 1	TN	48	1	5	LED	240			
2	20/1	ON	EXIT	5	1	20	LED		100		
3	20/1	NOTE 1	TM	12	2	35	FL			840	
4	20/1	NOTE 1	TM	8	2	32	FL	512			
5	20/1	NOTE 1	TF-1	5	1	50	FL		250		
6	20/1	NOTE 1	TL	18	1	35	FL			630	
7	20/1	NOTE 1	TN	12	1	5	LED	60			
8	20/1	ON	TT	2	2	35	FL		140		
9	20/1	NOTE 1	TN	15	1	5	LED			75	
10	20/1	SPARE						0			
11	20/1	SPARE							0		
12	20/1	SPARE								0	
NOTE 1: TO BE DETERMINED BY LIGHTING CONSULTANT							VA/PHASE	812	490	1545	
							TOTAL [VA]	2847			
							TOTAL [A]	8			

DIMMER PANELBOARD SCHEDULE											
Panel: <u>3LP-DIM-1</u>				BUS: <u>200A</u>		Voltage: <u>208/120</u>					
Location: <u>AUDITORIUM/ STAGE</u>				MCB: <u>-</u>		Phase: <u>3P</u>					
Mounting: <u>SURFACE</u>				AIC: <u>22,000</u>		Wire: <u>4W</u>					
CIRCUIT		CONTROL	FIXTURE		LAMP			PHASE (W)			REMARKS
NO	BKR	ZONE	TYPE	QTY	QTY	W	TYPE	A	B	C	
1	20/1		TM	8	2	35		560			
2	20/1		TM	4	2	35			280		
3	20/1		TTE	1	1	1500				1500	
4	20/1		TTE	1	1	1500		1500			
5	20/1		TTE	1	1	1500			1500		
6	20/1		TTE	1	1	1500				1500	
7	20/1		TTE	1	1	1500		1500			
8	20/1		TTE	1	1	1500			1500		
9	20/1		TTE	1	1	1500				1500	
10	20/1		TTE	1	1	1500		1500			
11	20/1		TTE	1	1	1500			1500		
12	20/1		TTE	1	1	1500				1500	
13	20/1		TTE	1	1	1500		1500			
14	20/1		TTE	1	1	1500			1500		
15	20/1		TTE	1	1	1500				1500	
16	20/1		TTE	1	1	1500		1500			
17	20/1		TTE	1	1	1500			1500		
18	20/1		TTE	1	1	1500				1500	
19	20/1		TTH	2	1	750		1500			
20	20/1		TTH	2	1	750			1500		
21	20/1		TTH	2	1	750				1500	
22	20/1		TTH	2	1	750		1500			
23	20/1		TR	32	1	20			640		
24	20/1		TAA	16	1	50				800	

25	20/1		TAA	16	1	50		800			
26	20/1		TTD	1	1	1500			1500		
27	20/1		TTD	1	1	1500				1500	
28	20/1		TTD	1	1	1500		1500			
29	20/1		TTD	1	1	1500			1500		
30	20/1		TTD	1	1	1500				1500	
31	20/1		TTD	1	1	1500		1500			
32	20/1		TTD	1	1	1500			1500		
33	20/1		TTD	1	1	1500				1500	
34	20/1		TR	32	1	20		640			
35	20/1		SPARE						0		
36	20/1		SPARE							0	
37	20/1		SPARE					0			
38	20/1		SPARE						0		
39	20/1		SPARE							0	
40	20/1		SPARE					0			
41	20/1		SPARE						0		
42	20/1		SPARE							0	
43	20/1		SPARE					0			
44	20/1		SPARE						0		
45	20/1		SPARE							0	
46	20/1		SPARE					0			
47	20/1		SPARE						0		
48	20/1		SPARE							0	
VA/PHASE								15500	14420	15800	
TOTAL [VA]								45720			
TOTAL [A]								127			

The panel below, 3LP-DIM-2, is the panel that contains only theatrical fixtures. As such, it is not being redesigned or altered in any way. Note that it contains no green highlights as it contains no normal lighting fixtures.

DIMMER PANELBOARD SCHEDULE											
Panel: <u>3LP-DIM-2</u>				BUS: <u>200A</u>				Voltage: <u>208/120</u>			
Location: <u>AUDITORIUM/ STAGE</u>				MCB: <u>-</u>				Phase: <u>3P</u>			
Mounting: <u>SURFACE</u>				AIC: <u>22,000</u>				Wire: <u>4W</u>			
CIRCUIT		CONTROL ZONE	FIXTURE		LAMP			PHASE (W)			REMARKS
NO	BKR		TYPE	QTY	QTY	W	TYPE	A	B	C	
1	20/1		TTA	1	1	1500		1500			STAGE
2	20/1		TTA	1	1	1500			1500		STAGE
3	20/1		TTA	1	1	1500				1500	STAGE
4	20/1		TTA	1	1	1500		1500			STAGE
5	20/1		TTA	1	1	1500			1500		STAGE
6	20/1		TTA	1	1	1500				1500	STAGE
7	20/1		TTA	1	1	1500		1500			STAGE
8	20/1		TTA	1	1	1500			1500		STAGE
9	20/1		TTA	1	1	1500				1500	STAGE
10	20/1		TTA	1	1	1500		1500			STAGE
11	20/1		TTA	1	1	1500			1500		STAGE
12	20/1		TTA	1	1	1500				1500	STAGE
13	20/1		TTA	1	1	1500		1500			STAGE
14	20/1		TTA	1	1	1500			1500		STAGE
15	20/1		TTA	1	1	1500				1500	STAGE
16	20/1		TTA	1	1	1500		1500			STAGE
17	20/1		TTA	1	1	1500			1500		STAGE
18	20/1		TTA	1	1	1500				1500	STAGE
19	20/1		TTA	1	1	1500		1500			STAGE
20	20/1		TTA	1	1	1500			1500		STAGE
21	20/1		TTA	1	1	1500				1500	STAGE
22	20/1		TTA	1	1	1500		1500			STAGE
23	20/1		TTA	1	1	1500			1500		STAGE
24	20/1		TTA	1	1	1500				1500	STAGE

25	20/1		TTA	1	1	1500		1500			STAGE
26	20/1		TTA	1	1	1500			1500		STAGE
27	20/1		TTA	1	1	1500				1500	STAGE
28	20/1		TTA	1	1	1500		1500			STAGE
29	20/1		TTA	1	1	1500			1500		STAGE
30	20/1		TTA	1	1	1500				1500	STAGE
31	20/1		TTA	1	1	1500		1500			STAGE
32	20/1		TTA	1	1	1500			1500		STAGE
33	20/1		TTC	1	3	500				1500	STAGE FLOOR
34	20/1		TTC	1	3	500		1500			STAGE FLOOR
35	20/1		TTC	1	3	500			1500		STAGE FLOOR
36	20/1		TTC	1	3	500				1500	STAGE FLOOR
37	20/1		TTC	1	3	500		1500			STAGE FLOOR
38	20/1		TTC	1	3	500			1500		STAGE FLOOR
39	20/1		TTC	1	3	500				1500	STAGE FLOOR
40	20/1		TTC	1	3	500		1500			STAGE FLOOR
41	20/1		SPARE						0		
42	20/1		SPARE							0	
43	20/1		SPARE					0			
44	20/1		SPARE						0		
45	20/1		SPARE							0	
46	20/1		SPARE					0			
47	20/1		SPARE						0		
48	20/1		SPARE							0	
VA/PHASE								21000	19500	19500	
TOTAL [VA]								60000			
TOTAL [A]								167			

v. Panelboard Worksheets

1LP-A

PANELBOARD SIZING WORKSHEET											
Panel Tag----->					1LP-A	Panel Location:			1ST FLR ELEC CLOSET		
Nominal Phase to Neutral Voltage----->					120	Phase:			3		
Nominal Phase to Phase Voltage----->					208	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	LIGHTING	3	RM 101,103	800	VA	0.90	720	800		
2	A	LIGHTING	3	CORRIDOR	1100	VA	0.90	990	1100		
3	B	LIGHTING	3	RM 101, 103	800	VA	0.90	720	800		
4	B	LIGHTING	3	CORRIDOR	1100	VA	0.90	990	1100		
5	C	LIGHTING	3	RM 105	1200	VA	0.90	1080	1200		
6	C	LIGHTING	3	STAIR A	1100	VA	0.90	990	1100		
7	A	LIGHTING	3	RM 102,134,106	900	VA	0.90	810	900		
8	A	LIGHTING	3	STAIR B	1100	VA	0.90	990	1100		
9	B	LIGHTING	3	RM 107-109	700	VA	0.90	630	700		
10	B	LIGHTING	3	2ND FLR STAIR C	800	VA	0.90	720	800		
11	C	LIGHTING	3	RM 134,144	800	VA	0.90	720	800		
12	C	LIGHTING	3	TOILETS 133	400	VA	0.90	360	400		
13	A	LIGHTING	3	RM 145, 141	800	VA	0.90	720	800		
14	A	SPARE		-	0	VA	0.90	0	0		
15	B	LIGHTING	3	RM 113-115	900	VA	0.90	810	900		
16	B	SPARE		-	0	VA	0.90	0	0		
17	C	LIGHTING	3	RM121,123,126	800	VA	0.90	720	800		
18	C	SPARE		-	0	VA	0.90	0	0		
19	A	LIGHTING	3	RM 118-122	900	VA	0.90	810	900		
20	A	SPARE		-	0	VA	0.90	0	0		
21	B	LTG	3	EXTERIOR	960	VA	0.70	672	960	FAÇADE EXTERIOR	
22	B	SPARE		-	0	VA	0.90	0	0		
23	C	SPARE	3	-	0	VA	0.90	0	0	PREVIOUSLY FAÇADE	
24	C	SPARE		-	0	VA	0.90	0	0		
25	A	SPARE		-	0	VA	0.90	0	0		
26	A	SPARE		-	0	VA	0.90	0	0		
27	B	SPARE		-	0	VA	0.90	0	0		
28	B	SPARE		-	0	VA	0.90	0	0		
29	C	SPARE		-	0	VA	0.90	0	0		
30	C	SPARE		-	0	VA	0.90	0	0		
PANEL TOTAL								13.5	15.2	Amps=	42.1

PHASE LOADING									kW	kVA	%	Amps
PHASE TOTAL				A					5.0	5.6	37%	46.7
PHASE TOTAL				B					4.5	5.3	35%	43.8
PHASE TOTAL				C					3.9	4.3	28%	35.8

LOAD CATAGORIES		Connected			Demand				Ver. 1.04
		kW	kVA	DF	kW	kVA	PF		
1	receptacles	0.0	0.0		0.0	0.0			
2	computers	0.0	0.0		0.0	0.0			
3	fluorescent lighting	13.5	15.2	1.00	13.5	15.2	0.89		
4	HID lighting	0.0	0.0		0.0	0.0			
5	incandescent lighting	0.0	0.0		0.0	0.0			
6	HVAC fans	0.0	0.0		0.0	0.0			
7	heating	0.0	0.0		0.0	0.0			
8	kitchen equipment	0.0	0.0		0.0	0.0			
9	unassigned	0.0	0.0		0.0	0.0			
Total Demand Loads					13.5	15.2			
Spare Capacity		20%			2.7	3.0			
Total Design Loads					16.1	18.2	0.89	Amps= 50.5	

Default Power Factor =	0.80
Default Demand Factor =	100 %

PANELBOARD SCHEDULE													
VOLTAGE: 208Y/120V,3PH,4W			PANEL TAG: 1LP-A						MIN. C/B AIC: 10K				
SIZE/TYPE BUS: 225A			PANEL LOCATION: 1ST FLR ELEC CLOSET						OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD 1L1B				
SIZE/TYPE MAIN: 225A/3P C/B			PANEL MOUNTING: SURFACE										
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION	
LIGHTING	RM 101,103	720	20A/1P	1	*			2	20A/1P	990	CORRIDOR	LIGHTING	
LIGHTING	RM 101, 103	720	20A/1P	3		*		4	20A/1P	990	CORRIDOR	LIGHTING	
LIGHTING	RM 105	1080	20A/1P	5			*	6	20A/1P	990	STAIR A	LIGHTING	
LIGHTING	RM 102,134,106	810	20A/1P	7	*			8	20A/1P	990	STAIR B	LIGHTING	
LIGHTING	RM 107-109	630	20A/1P	9		*		10	20A/1P	720	2ND FLR STAIR C	LIGHTING	
LIGHTING	RM 134,144	720	20A/1P	11			*	12	20A/1P	360	TOILETS 133	LIGHTING	
LIGHTING	RM 145, 141	720	20A/1P	13	*			14	20A/1P	0	-	SPARE	
LIGHTING	RM 113-115	810	20A/1P	15		*		16	20A/1P	0	-	SPARE	
LIGHTING	RM121,123,126	720	20A/1P	17			*	18	20A/1P	0	-	SPARE	
LIGHTING	RM 118-122	810	20A/1P	19	*			20	20A/1P	0	-	SPARE	
LTG	EXTERIOR	672	20A/1P	21		*		22	20A/1P	0	-	SPARE	
SPARE	-	0	20A/1P	23			*	24	20A/1P	0	-	SPARE	
SPARE	-	0	20A/1P	25	*			26	20A/1P	0	-	SPARE	
SPARE	-	0	20A/1P	27		*		28	20A/1P	0	-	SPARE	
SPARE	-	0	20A/1P	29			*	30	20A/1P	0	-	SPARE	
0	0	0	20A/1P	31	*			32	20A/1P	0	0	0	
0	0	0	20A/1P	33		*		34	20A/1P	0	0	0	
0	0	0	20A/1P	35			*	36	20A/1P	0	0	0	
0	0	0	20A/1P	37	*			38	20A/1P	0	-	-	
-		0	20A/1P	39		*		40	20A/1P	0	-	-	
-		0	20A/1P	41			*	42	20A/1P	0	-	-	
CONNECTED LOAD (KW) - A Ph.		5.04							TOTAL DESIGN LOAD (KW)		16.14		
CONNECTED LOAD (KW) - B Ph.		4.54							POWER FACTOR		0.89		
CONNECTED LOAD (KW) - C Ph.		3.87							TOTAL DESIGN LOAD (AMPS)		51		

1ERP-LS

PANELBOARD SIZING WORKSHEET										
Panel Tag----->					1ERP-LS	Panel Location:			5TH FLR ELEC. CLOSET	
Nominal Phase to Neutral Voltage----->					120	Phase:			3	
Nominal Phase to Phase Voltage----->					208	Wires:			4	
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	EM LIGHTING	3	1ST FLR CORRDR	1100	VA	0.90	990	1100	HS Art Room/IS CAFÉ
2	A	EM LIGHTING	3	2ND FLR EXIT SIGNS	300	VA	0.90	270	300	
3	B	EM LIGHTING	3	1ST FLR CORRDR	600	VA	0.90	540	600	
4	B	EM LIGHTING	3	2ND FLR CORRDR	800	VA	0.90	720	800	
5	C	EM LIGHTING	3	1ST FLR EXIT SIGNS	300	VA	0.90	270	300	
6	C	EM LIGHTING	3	LIBRARY 205	1000	VA	0.90	900	1000	
7	A	EM LIGHTING	3	1ST FLR GYM	600	VA	0.90	540	600	
8	A	EM LIGHTING	3	RM 230,240	500	VA	0.90	450	500	
9	B	EM LIGHTING	3	RM133,14,17,23,19,33	1100	VA	0.90	990	1100	
10	B	EM LIGHTING	3	RM 212,233	200	VA	0.90	180	200	
11	C	EM LIGHTING	3	RM 134,144	600	VA	0.90	540	600	
12	C	EM LIGHTING	3	RM 213	500	VA	0.90	450	500	
13	A	EM LIGHTING	3	STAIR A	1500	VA	0.90	1350	1500	
14	A	SPARE		-	0	VA	0.90	0	0	
15	B	EM LIGHTING	3	STAIR B	1500	VA	0.90	1350	1500	
16	B	SPARE		-	0	VA	0.90	0	0	
17	C	EM LIGHTING	3	STAIR C	800	VA	0.90	720	800	
18	C	SPARE		-	0	VA	0.90	0	0	
19	A	EM LIGHTING	3	GYM CEILING	1000	VA	0.90	900	1000	
20	A	SPARE		-	0	VA	0.90	0	0	
21	B	EM LIGHTING	3	GYM CEILING	1000	VA	0.70	700	1000	
22	B	SPARE		-	0	VA	0.90	0	0	
23	C	EM LIGHTING	3	GYM CEILING	1000	VA	0.90	900	1000	
24	C	SPARE		-	0	VA	0.90	0	0	
25	A	EM LIGHTING	3	GYM CEILING	1000	VA	0.90	900	1000	
26	A	SPARE		-	0	VA	0.90	0	0	
27	B	EM LIGHTING	3	1ST FLR GYM	600	VA	0.90	540	600	
28	B	EM LIGHTING	3	EXIT DOOR	42	VA	0.90	38	42	FAÇADE
29	C	SPARE		-	0	VA	0.90	0	0	
30	C	EM LIGHTING	3	ENTRANCE	350	VA	0.90	315	350	FAÇADE
PANEL TOTAL								14.6	16.4	Amps= 45.5

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL		A				5.4	6.0	37%	50.0
PHASE TOTAL		B				5.1	5.8	36%	48.7
PHASE TOTAL		C				4.1	4.6	28%	37.9

LOAD CATEGORIES		Connected			Demand				Ver. 104
		kW	kVA	DF	kW	kVA	PF		
1	receptacles	0.0	0.0		0.0	0.0			
2	computers	0.0	0.0		0.0	0.0			
3	fluorescent lighting	14.6	16.4	1.00	14.6	16.4	0.89		
4	HID lighting	0.0	0.0		0.0	0.0			
5	incandescent lighting	0.0	0.0		0.0	0.0			
6	HVAC fans	0.0	0.0		0.0	0.0			
7	heating	0.0	0.0		0.0	0.0			
8	kitchen equipment	0.0	0.0		0.0	0.0			
9	unassigned	0.0	0.0		0.0	0.0			
Total Demand Loads					14.6	16.4			
Spare Capacity		20%			2.9	3.3			
Total Design Loads					17.5	19.7	0.89	Amps= 54.6	

Default Power Factor =	0.80	
Default Demand Factor =	100	%

PANELBOARD SCHEDULE												
VOLTAGE: 208Y/120V,3PH,4W			PANEL TAG: 1ERP-LS					MIN. C/B AIC: 10K				
SIZE/TYPE BUS: 225A			PANEL LOCATION: 5TH FLR ELEC. CLOSET					OPTIONS: PROVIDE FEED THROUGH LUGS				
SIZE/TYPE MAIN: 225A/3P C/B			PANEL MOUNTING: SURFACE					FOR PANELBOARD 1L1B				
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
EM LIGHTING	ST FLR CORR	990	20A/1P	1	*			2	20A/1P	270	D FLR EXIT SIG	EM LIGHTING
EM LIGHTING	ST FLR CORR	540	20A/1P	3		*		4	20A/1P	720	ND FLR CORR	EM LIGHTING
EM LIGHTING	T FLR EXIT SIG	270	20A/1P	5			*	6	20A/1P	900	LIBRARY 205	EM LIGHTING
EM LIGHTING	1ST FLR GYM	540	20A/1P	7	*			8	20A/1P	450	RM 230,240	EM LIGHTING
EM LIGHTING	133,14,17,23,19	990	20A/1P	9			*	10	20A/1P	180	RM 212,233	EM LIGHTING
EM LIGHTING	RM 134,144	540	20A/1P	11			*	12	20A/1P	450	RM 213	EM LIGHTING
EM LIGHTING	STAIR A	1350	20A/1P	13	*			14	20A/1P	0	-	SPARE
EM LIGHTING	STAIR B	1350	20A/1P	15		*		16	20A/1P	0	-	SPARE
EM LIGHTING	STAIR C	720	20A/1P	17			*	18	20A/1P	0	-	SPARE
EM LIGHTING	GYM CEILING	900	20A/1P	19	*			20	20A/1P	0	-	SPARE
EM LIGHTING	GYM CEILING	700	20A/1P	21		*		22	20A/1P	0	-	SPARE
EM LIGHTING	GYM CEILING	900	20A/1P	23			*	24	20A/1P	0	-	SPARE
EM LIGHTING	GYM CEILING	900	20A/1P	25	*			26	20A/1P	0	-	SPARE
EM LIGHTING	1ST FLR GYM	540	20A/1P	27		*		28	20A/1P	38	EXIT DOOR	EM LIGHTING
SPARE	-	0	20A/1P	29			*	30	20A/1P	315	ENTRANCE	EM LIGHTING
0	0	0	20A/1P	31	*			32	20A/1P	0	0	0
0	0	0	20A/1P	33		*		34	20A/1P	0	0	0
0	0	0	20A/1P	35			*	36	20A/1P	0	0	0
0	0	0	20A/1P	37	*			38	20A/1P	0	-	-
-	0	0	20A/1P	39		*		40	20A/1P	0	-	-
-	0	0	20A/1P	41			*	42	20A/1P	0	-	-
CONNECTED LOAD (KW) - A Ph.		5.40						TOTAL DESIGN LOAD (KW)		17.46		
CONNECTED LOAD (KW) - B Ph.		5.06						POWER FACTOR		0.89		
CONNECTED LOAD (KW) - C Ph.		4.10						TOTAL DESIGN LOAD (AMPS)		55		

5LP-A

PANELBOARD SIZING WORKSHEET											
Panel Tag----->					5LP-A	Panel Location:			5TH FLR ELEC. CLOSET		
Nominal Phase to Neutral Voltage----->					120	Phase:			3		
Nominal Phase to Phase Voltage----->					208	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	LIGHTING	3	RM 505	1200	VA	0.90	1080	1200		
2	A	LIGHTING	3	Corridor	900	VA	0.90	810	900		
3	B	LIGHTING	3	RM 513	700	VA	0.90	630	700		
4	B	LIGHTING	3	RM,539,541,545	400	VA	0.90	360	400		
5	C	LIGHTING	3	-	0	VA	0.90	0	0		
6	C	LIGHTING	3	TOILETS	400	VA	0.90	360	400		
7	A	LIGHTING	3	RM 526	1100	VA	0.90	990	1100		
8	A	LIGHTING	3	RM 519	900	VA	0.90	810	900		
9	B	LIGHTING	3	RM 519	1300	VA	0.90	1170	1300		
10	B	LIGHTING	3	RM 523	600	VA	0.90	540	600		
11	C	LIGHTING	3	RM 521,523	1300	VA	0.90	1170	1300		
12	C	LIGHTING	3	RM 535	600	VA	0.90	540	600		
13	A	LIGHTING	3	RM 525	1200	VA	0.90	1080	1200		
14	A	LIGHTING	3	-	0	VA	0.90	0	0		
15	B	LIGHTING	3	RM 518, 522, 524	1100	VA	0.90	990	1100		
16	B	LIGHTING	3	-	0	VA	0.90	0	0		
17	C	LIGHTING	3	RM 506, 508, 534	800	VA	0.90	720	800		
18	C	LIGHTING	3	-	0	VA	0.90	0	0		
19	A	LIGHTING	3	RM 534,536,538	800	VA	0.90	720	800		
20	A	LIGHTING	3	-	0	VA	0.90	0	0		
21	B	LIGHTING	3	RM 546	1082	VA	0.70	757	1082	IS Cafeteria	
22	B	LIGHTING	3	ROOF MER	900	VA	0.90	810	900		
23	C	LIGHTING	3	RM 543	400	VA	0.90	360	400		
24	C	LIGHTING	3	ROOF EXTERIOR	600	VA	0.90	540	600		
25	A	LIGHTING	3	KITCHEN 534	800	VA	0.90	720	800		
26	A	LIGHTING	3	ROOF EXT.	600	VA	0.90	540	600		
27	B	LIGHTING	3	RM 552	1073	VA	0.90	966	1073	HS Art Room	
28	B	LIGHTING	3	ROOF EXT.	600	VA	0.90	540	600		
29	C	LIGHTING	3	RM 547,549,551	1000	VA	0.90	900	1000		
30	C	SPARE		-	0	VA	0.90	0	0		
31	A	SPARE		-	0	VA	0.90	0	0		
32	A	SPARE		-	0	VA	0.90	0	0		
33	B	SPARE		-	0	VA	0.90	0	0		
34	B	SPARE		-	0	VA	0.90	0	0		
35	C	SPARE		-	0	VA	0.90	0	0		
36	C	SPARE		-	0	VA	0.90	0	0		
PANEL TOTAL								18.1	20.4	Amps=	56.5

PHASE LOADING							kW	kVA	%	Amps
PHASE TOTAL		A					6.8	7.5	39%	62.5
PHASE TOTAL		B					5.8	6.7	35%	55.7
PHASE TOTAL		C					4.6	5.1	26%	42.5

LOAD CATAGORIES		Connected			Demand				Ver. 104
		kW	kVA	DF	kW	kVA	PF		
1	receptacles	0.0	0.0		0.0	0.0			
2	computers	0.0	0.0		0.0	0.0			
3	fluorescent lighting	17.1	19.3	1.00	17.1	19.3	0.89		
4	HID lighting	0.0	0.0		0.0	0.0			
5	incandescent lighting	0.0	0.0		0.0	0.0			
6	HVAC fans	0.0	0.0		0.0	0.0			
7	heating	0.0	0.0		0.0	0.0			
8	kitchen equipment	0.0	0.0		0.0	0.0			
9	unassigned	0.0	0.0		0.0	0.0			
Total Demand Loads					17.1	19.3			
Spare Capacity		20%			3.4	3.9			
Total Design Loads					20.6	23.1	0.89	Amps= 64.3	

Default Power Factor =	0.80
Default Demand Factor =	100 %

PANELBOARD SCHEDULE													
VOLTAGE: 208Y/120V,3PH,4W			PANEL TAG: 5LP-A						MIN. C/B AIC: 10K				
SIZE/TYPE BUS: 225A			PANEL LOCATION: 5TH FLR ELEC. CLOSET						OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD 1L1B				
SIZE/TYPE MAIN: 225A/3P C/B			PANEL MOUNTING: SURFACE										
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION	
LIGHTING	RM 505	1080	20A/1P	1	*			2	20A/1P	810	Corridor	LIGHTING	
LIGHTING	RM 513	630	20A/1P	3		*		4	20A/1P	360	RM,539,541,545	LIGHTING	
LIGHTING	-	0	20A/1P	5			*	6	20A/1P	360	TOILETS	LIGHTING	
LIGHTING	RM 526	990	20A/1P	7	*			8	20A/1P	810	RM 519	LIGHTING	
LIGHTING	RM 519	1170	20A/1P	9		*		10	20A/1P	540	RM 523	LIGHTING	
LIGHTING	RM 521,523	1170	20A/1P	11			*	12	20A/1P	540	RM 535	LIGHTING	
LIGHTING	RM 525	1080	20A/1P	13	*			14	20A/1P	0	-	LIGHTING	
LIGHTING	RM 518, 522, 52	990	20A/1P	15		*		16	20A/1P	0	-	LIGHTING	
LIGHTING	RM 506, 508, 53	720	20A/1P	17			*	18	20A/1P	0	-	LIGHTING	
LIGHTING	RM 534,536,538	720	20A/1P	19	*			20	20A/1P	0	-	LIGHTING	
LIGHTING	RM 546	757	20A/1P	21		*		22	20A/1P	810	ROOF MER	LIGHTING	
LIGHTING	RM 543	360	20A/1P	23			*	24	20A/1P	540	ROOF EXTERIOR	LIGHTING	
LIGHTING	KITCHEN 534	720	20A/1P	25	*			26	20A/1P	540	ROOF EXT.	LIGHTING	
LIGHTING	RM 552	966	20A/1P	27		*		28	20A/1P	540	ROOF EXT.	LIGHTING	
LIGHTING	RM 547,549,551	900	20A/1P	29			*	30	20A/1P	0	-	SPARE	
SPARE	-	0	20A/1P	31	*			32	20A/1P	0	-	SPARE	
SPARE	-	0	20A/1P	33		*		34	20A/1P	0	-	SPARE	
SPARE	-	0	20A/1P	35			*	36	20A/1P	0	-	SPARE	
0		0	20A/1P	37	*			38	20A/1P	0	-	-	
-		0	20A/1P	39		*		40	20A/1P	0	-	-	
-		0	20A/1P	41			*	42	20A/1P	0	-	-	
CONNECTED LOAD (KW) - A Ph.		6.75							TOTAL DESIGN LOAD (KW)		21.72		
CONNECTED LOAD (KW) - B Ph.		6.76							POWER FACTOR		0.89		
CONNECTED LOAD (KW) - C Ph.		4.59							TOTAL DESIGN LOAD (AMPS)		68		

5ELP-LS

PANELBOARD SIZING WORKSHEET										
Panel Tag----->					5ELP-LS	Panel Location:			5TH FLR ELEC. CLOSET	
Nominal Phase to Neutral Voltage----->					120	Phase:			3	
Nominal Phase to Phase Voltage----->					208	Wires:			4	
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks
1	A	EM LIGHTING	3	5TH FLR	300	VA	0.90	270	300	HS Art Room/IS CAFÉ
2	A	EM LIGHTING	3	RM 601,603,604	600	VA	0.90	540	600	
3	B	EM LIGHTING	3	5TH FLR KITCHEN	700	VA	0.90	630	700	
4	B	SPARE		-	0	VA	0.90	0	0	
5	C	EM LIGHTING	3	5TH FLR HS CAFÉ	800	VA	0.90	720	800	
6	C	SPARE		-	0	VA	0.90	0	0	
7	A	EM LIGHTING	3	5TH FLR IS CAFÉ	360	VA	0.90	324	360	IS CAFÉ
8	A	SPARE		-	0	VA	0.90	0	0	
9	B	EM LIGHTING	3	RM 514,535	300	VA	0.90	270	300	
10	B	SPARE		-	0	VA	0.90	0	0	
11	C	EM LIGHTING	3	5TH FLR CORRDR	800	VA	0.90	720	800	
12	C	SPARE		-	0	VA	0.90	0	0	
13	A	EM LIGHTING	3	TERRACE	1458	VA	0.90	1312	1458	TERRACE
14	A	SPARE		-	0	VA	0.90	0	0	
15	B	EM LIGHTING	3	RM 517	400	VA	0.90	360	400	
16	B	SPARE		-	0	VA	0.90	0	0	
17	C	SPARE		-	0	VA	0.90	0	0	
18	C	SPARE		-	0	VA	0.90	0	0	
PANEL TOTAL								5.1	5.7	Amps= 15.9

PHASE LOADING							kW	kVA	%	Amps
PHASE TOTAL		A					2.4	2.7	48%	22.7
PHASE TOTAL		B					1.3	1.4	24%	11.7
PHASE TOTAL		C					1.4	1.6	28%	13.3
LOAD CATAGORIES		Connected			Demand			Ver. 1.04		
		kW	kVA	DF	kW	kVA	PF			
1	receptacles	0.0	0.0		0.0	0.0				
2	computers	0.0	0.0		0.0	0.0				
3	fluorescent lighting	5.1	5.7	1.00	5.1	5.7	0.90			
4	HID lighting	0.0	0.0		0.0	0.0				
5	incandescent lighting	0.0	0.0		0.0	0.0				
6	HVAC fans	0.0	0.0		0.0	0.0				
7	heating	0.0	0.0		0.0	0.0				
8	kitchen equipment	0.0	0.0		0.0	0.0				
9	unassigned	0.0	0.0		0.0	0.0				
Total Demand Loads					5.1	5.7				
Spare Capacity		20%			1.0	1.1				
Total Design Loads					6.2	6.9	0.90	Amps=	19.1	

Default Power Factor =	0.80	
Default Demand Factor =	100	%

PANELBOARD SCHEDULE												
VOLTAGE: 208Y/120V,3PH,4W			PANEL TAG: 5ELP-LS						MIN. C/B AIC: 10K			
SIZE/TYPE BUS: 225A			PANEL LOCATION: 5TH FLR ELEC. CLOSET						OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD 1L1B			
SIZE/TYPE MAIN: 225A/3P C/B			PANEL MOUNTING: SURFACE									
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
EM LIGHTING	5TH FLR	270	20A/1P	1	*			2	20A/1P	540	RM 601,603,604	EM LIGHTING
EM LIGHTING	TH FLR KITCHE	630	20A/1P	3		*		4	20A/1P	0	-	SPARE
EM LIGHTING	TH FLR HS CAF	720	20A/1P	5			*	6	20A/1P	0	-	SPARE
EM LIGHTING	TH FLR IS CAF	324	20A/1P	7	*			8	20A/1P	0	-	SPARE
EM LIGHTING	RM 514,535	270	20A/1P	9		*		10	20A/1P	0	-	SPARE
EM LIGHTING	TH FLR CORR	720	20A/1P	11			*	12	20A/1P	0	-	SPARE
EM LIGHTING	TERRACE	1312	20A/1P	13	*			14	20A/1P	0	-	SPARE
EM LIGHTING	RM 517	360	20A/1P	15		*		16	20A/1P	0	-	SPARE
SPARE	-	0	20A/1P	17			*	18	20A/1P	0	-	SPARE
0	0	0	20A/1P	19	*			20	20A/1P	0	0	0
0	0	0	20A/1P	21		*		22	20A/1P	0	0	0
0	0	0	20A/1P	23			*	24	20A/1P	0	0	0
0	0	0	20A/1P	25	*			26	20A/1P	0	0	0
0	0	0	20A/1P	27		*		28	20A/1P	0	0	0
0	0	0	20A/1P	29			*	30	20A/1P	0	0	0
0	0	0	20A/1P	31	*			32	20A/1P	0	0	0
0	0	0	20A/1P	33		*		34	20A/1P	0	0	0
0	0	0	20A/1P	35			*	36	20A/1P	0	0	0
0	0	0	20A/1P	37	*			38	20A/1P	0	-	-
-	-	0	20A/1P	39		*		40	20A/1P	0	-	-
-	-	0	20A/1P	41			*	42	20A/1P	0	-	-
CONNECTED LOAD (KW) - A Ph.		2.45							TOTAL DESIGN LOAD (KW)		6.18	
CONNECTED LOAD (KW) - B Ph.		1.26							POWER FACTOR		0.90	
CONNECTED LOAD (KW) - C Ph.		1.44							TOTAL DESIGN LOAD (AMPS)		19	

vi. Revised Panelboard Schedules / Dimming Panels

This section shows the changes made to the existing electrical panelboards to accommodate the new lighting design. Each affected circuit is highlighted, in color, according to the space that it feeds. The color of the highlight corresponds to the color assigned to each space under the electrical section "1b. Panelboards." Before each panelboard, the electrical calculation for each circuit is presented. This is to show how the load for each circuit was calculated. The tables below (4 in total, 1 for each space), show information regarding the luminaire which includes: type, lamp, quantity, watts per fixture, total consumed wattage (for all fixtures of that type in the space), power factor, volt-amperes per fixture, and total consumed volt-amperes (for all fixtures of that type in the space). The values presented in this table those which were used to calculate branch circuit load. See individual panelboards for details.

FAÇADE VA CALCULATION								
Location	Type	Lamp	Qty	W/Fixture	Total Watts	PF	VA/Fixture	Total VA
Façade	A1	LED	168 ft	4 W/ft	672	0.7	5.7 VA/ft	960
	B1	(1) F32T8	1	38	38	0.9	42	42
	C1	LED	50 ft	2.4 W/ft	120	0.7	3.9 VA/ft	171
	D1	LED	24 ft	4.5 W/ft	108	0.7	6.4 W/ft	154
Terrace	F1	(1) PSMH	7	164	1312	0.9	182	1458

AUDITORIUM VA CALCULATION								
Location	Type	Lamp	Qty	W/Fixture	Total Watts	PF	VA/Fixture	Total VA
Auditorium	A2	(1) F32T8	20	38	760	0.9	42	844
	B2	(1) F32T8	12	38	456	0.9	42	507
	C2	(1) 32CFTR	4	36	144	0.9	40	160
	D2	(1) F32T8	16	38	608	0.9	42	676
	EX	LED	2	5	10	0.7	7	14

IS CAFETERIA VA CALCULATION								
Location	Type	Lamp	Qty	W/Fixture	Total Watts	PF	VA/Fixture	Total VA
IS Café	A3	(1) F32T8	24	38	912	0.9	42	1013
	B3	(1) F32T8	10	38	380	0.9	42	422
	C3	LED	6	9	54	0.7	13	77
	EX	LED	2	5	10	0.7	7	14

HS ART ROOM VA CALCULATION								
Location	Type	Lamp	Qty	W/Fixture	Total Watts	PF	VA/Fixture	Total VA
HS Art Room	A4	(1) F32T8	14	38	532	0.9	42	591
	B4	(1) F32T8	4	38	152	0.9	42	169
	C4	(1) 32CFTR	8	35	280	0.9	39	311
	EX	LED	1	5	5	0.7	7	7

PNL 5LP-A, CKT. 21

Total VA = (# Type A Luminaires)*(VA / Luminaire) + (# Type B luminaires)*(VA/luminaires) + (# Type C luminaires)*(VA/Luminaire)

Total VA = (20)(38)+(8)(38)+ (2)(9) = 1082VA

PNL 5LP-A, CKT. 27

Total VA = (# Type A1 Luminaires)*(VA / Luminaire) + (# Type A2 luminaires)*(VA/luminaires) + (# Type B luminaires)*(VA/Luminaire)

Total VA = (14)(42)+(4)(42)+ (8)(39) = 1078VA

PANELBOARD SCHEDULE												
Panel:		5LP-A		BUS:		100A		Voltage:		208/120		
Location:		5TH FLR. ELEC. CLOSET		MCB:		100A		Phase:		3P		
Mounting:		SURFACE		AIC:		22,000		Wire:		4W		
CKT NO	CB	LOAD DESCRIPTION	Load VA						LOAD DESCRIPTION	CB	CKT NO	
			A		B		C					
1	20/1	RM 505,511, LTG	1200	900						CORRIDOR, LTG	20/1	2
3	20/1	RM 513, LTG			700	400				RM 539, 541, 545, LTG	20/1	4
5	20/1	SPARE					0	400		TOILETS, LTG	20/1	6
7	20/1	RM 526, LTG	1100	900						RM 519, LTG	20/1	8
9	20/1	RM 519, LTG			1300	600				RM 523, LTG	20/1	10
11	20/1	RM 521,523, LTG					1300	600		RM 535, LTG	20/1	12
13	20/1	RM 525, LTG	1200	*						SPARE	20/1	14
15	20/1	RM 518, 522, 524, LTG			1100	*				SPARE	20/1	16
17	20/1	RM 506, 508, 534, LTG					800	*		SPARE	20/1	18
19	20/1	RM 534, 536, 538, LTG	800	*						SPARE	20/1	20
21	20/1	RM 546, LTG			1082	900				ROOF MER, LTG	20/1	22
23	20/1	RM 543, LTG					400	600		ROOF EXTERIOR, LTG	20/1	24
25	20/1	KITCHEN 534, LTG	800	600						ROOF EXTERIOR, LTG	20/1	26
27	20/1	RM 552, LTG			1078	600				ROOF EXTERIOR, LTG	20/1	28
29	20/1	RM 547, 549, 551, LTG					1000	*		SPARE	20/1	30
31	20/1	SPARE	*	*						SPARE	20/1	32
33	20/1	SPARE			*	*				SPARE	20/1	34
35	20/1	SPARE					*	*		SPARE	20/1	36
VA/PHASE			7500		7760		5100					
TOTAL [VA]			20360									
TOTAL [A]			56.56									

PNL 5ELP-LS, CKT. 1

Load and wiring for circuit 1 is existing-to-remain. It is highlighted here to show that it has been considered. Locations and quantity of exit signs will remain unchanged, and as such, the circuit that contains them will remain unchanged. Notice that this circuit is highlighted with a gradient of two colors as it supplies the exit signs for two of my spaces—IS Cafeteria and HS Art Room.

PNL 5ELP-LS, CKT. 7

Total VA = (# Type A Luminaires)*(VA / Luminaire) + (# Type B luminaires)*(VA/luminaires) + (# Type C luminaires)*(VA/Luminaire)

Total VA = (2)(42)+(2)(42)+(4)(13) = 220 VA

PNL 5ELP-LS, CKT. 13

Total VA = (# Type F1 Luminaires)*(VA / Luminaire) = (# Type D1 Luminaires)*[(Watts/Fixture) / PF]

Total VA = (8)*(164 / 0.9) = (8) * (193)

Total VA = 1458 VA

PANELBOARD SCHEDULE									
Panel: 5ELP-LS		BUS: 100A		Voltage: 208/120					
Location: 5TH FLR. ELEC. CLOSET		MCB: 60A		Phase: 3P					
Mounting: SURFACE		AIC: 22,000		Wire: 4W					
CKT NO	CB	LOAD DESCRIPTION	Load VA			LOAD DESCRIPTION	CB	CKT NO	
			A	B	C				
1	20/1	5TH FL EXIT SIGNS	300	600		RM 601, 603, 604	20/1	2	
3	20/1	5TH FL KITCHEN EM LTG		700	*	SPARE	20/1	4	
5	20/1	5TH FL HS CAFÉ EM LTG			800	SPARE	20/1	6	
7	20/1	5TH FL IS CAFÉ EM LTG	362	*		SPARE	20/1	8	
9	20/1	RM 514, 535		300	*	SPARE	20/1	10	
11	20/1	5TH FL CORRIDOR EM LTG			800	SPARE	20/1	12	
13	20/1	TERRACE LTG	1458	*		SPARE	20/1	14	
15	20/1	RM 517		400	*	SPARE	20/1	16	
17	20/1	SPARE			*	SPARE	20/1	18	
VA/PHASE			2720	1400	1600				
TOTAL [VA]			5720						
TOTAL [A]			15.89						

PNL 1LP-A, CKT. 21

Total VA = (Length of A1 fixture)*(VA / ft)

Total VA = (168 ft)(5.7 VA/ft) = 960 VA

PNL 1LP-A, CKT. 23

This circuit, which was originally occupied by exterior lighting, is no longer being used. It is highlighted to show that it has had the lighting load removed from it, and converted to a spare circuit. A single circuit, circuit 21 in this case, is sufficient enough to contain my exterior lighting design.

PANELBOARD SCHEDULE														
Panel:		1LP-A		BUS:		100A		Voltage:		208/120				
Location:		1ST FLR ELEC CLOSET		MCB:		100A		Phase:		3P				
Mounting:		SURFACE		AIC:		22,000		Wire:		4W				
CKT NO	CB	LOAD DESCRIPTION	Load VA						LOAD DESCRIPTION	CB	CKT NO			
			A		B		C							
1	20/1	RM 101, 103, LTG	800	1100										
3	20/1	RM 101, 103, LTG			800	1100								
5	20/1	RM 105, LTG					1200	1100						
7	20/1	RM 102, 134, 106, LTG	900	1100										
9	20/1	RM 107-109 LTG			700	800								
11	20/1	RM 134, 144, LTG					800	400						
13	20/1	RM 145, 141, LTG	800	*										
15	20/1	RM 113-115 LTG			900	*								
17	20/1	RM 121,123,126, LTG					800	*						
19	20/1	RM 118-122, LTG	900	*										
21	20/1	EXTERIOR LTG			960	*								
23	20/1	SPARE					*	*						
25	20/1	SPARE	*	*										
27	20/1	SPARE			*	*								
29	20/1	SPARE					*	*						
VA/PHASE			5600		5260		4300							
TOTAL [VA]			15160											
TOTAL [A]			42.11											

PNL 1ERP-LS, CKT. 28

Total VA = (# B1 Fixtures)*(VA / Fixture)
 Total VA = (1 fixture)(42 VA/fixture) = 42 VA.

PNL 1ERP-LS, CKT. 30

Total VA = (Length of C1 fixture)*(VA / ft) + (Length of D1 fixture)*(VA / ft) VA / Fixture
 Total VA = (50 ft)(3.9 VA/ft) + (24 ft)*(6.4 VA/ft) = 350 VA

PANELBOARD SCHEDULE											
Panel:		1ERP-LS		BUS:		100A		Voltage:		208/120	
Location:		1ST FLR ELEC CLOSET		MCB:		100A		Phase:		3P	
Mounting:		SURFACE		AIC:		22,000		Wire:		4W	
CKT NO	CB	LOAD DESCRIPTION	Load VA						LOAD DESCRIPTION	CB	CKT NO
			A		B		C				
1	20/1	1ST FL CORRDR EM LTG	1100	300					2ND FL EXIT SIGNS	20/1	2
3	20/1	1ST FL CORRDR EM LTG			600	800			2ND FL CORRDR EM LTG	20/1	4
5	20/1	1ST FL EXIT SIGNS					300	1000	LIBRARY 205	20/1	6
7	20/1	1ST FL GYM EM LTG	600	500					RM 230,240	20/1	8
9	20/1	RM 133,14,17,23,19,33			1100	200			RM 212,233	20/1	10
11	20/1	RM 134,144					600	500	RM 213	20/1	12
13	20/1	STAIR A EM LTG	1500	*					SPARE	20/1	14
15	20/1	STAIR B EM LTG			1500	*			SPARE	20/1	16
17	20/1	STAIR C EM LTG					800	*	SPARE	20/1	18
19	20/1	GYM CEILING EM LTG	1000	*					SPARE	20/1	20
21	20/1	GYM CEILING EM LTG			1000	*			SPARE	20/1	22
23	20/1	GYM CEILING EM LTG					1000	*	SPARE	20/1	24
25	20/1	GYM CEILING EM LTG	1000	*					SPARE	20/1	26
27	20/1	1ST FL GYM EM LTG			600	42			EXIT DOOR	20/1	28
29	20/1	SPARE					*	350	ENTRANCE	20/1	30
VA/PHASE			6000		5842		4550				
TOTAL [VA]			16392								
TOTAL [A]			45.53								

PNL 3ELP-DIM, CKT. 1

Total VA = (# D2 Fixtures)*(VA / Fixture)
 Total VA = (4 fixture)(42 VA/fixture) = 169 VA.

PNL 3ELP-DIM, CKT. 3

Total VA = (# B2 Fixtures)*(VA / Fixture)
 Total VA = (12 fixture)(42 VA/fixture) = 504 VA.

PNL 3ELP-DIM, CKT. 4

Total VA = (# C2 Fixtures)*(VA / Fixture)
 Total VA = (4 fixture)(40 VA/fixture) = 160 VA.

DIMMER PANELBOARD SCHEDULE											
Panel: <u>3ELP-DIM</u>			BUS: <u>200A</u>			Voltage: <u>208/120</u>					
Location: <u>AUDITORIUM</u>			MCB: <u>-</u>			Phase: <u>3P</u>					
Mounting: <u>SURFACE</u>			AIC: <u>22,000</u>			Wire: <u>4W</u>					
CIRCUIT		CONTROL	FIXTURE		LAMP			PHASE (VA)			REMARKS
NO	BKR	ZONE	TYPE	QTY	QTY	W	TYPE	A	B	C	
1	20/1	ae	D2	4	1	38	FL	169			
2	20/1	ON	EXIT	5	1	5	LED		25		
3	20/1	be	B2	12	1	38	FL			507	
4	20/1	ON	C2	4	1	36	FL	160			
5	20/1		SPARE						0		
6	20/1		SPARE							0	
7	20/1		SPARE					0			
8	20/1		SPARE						0		
9	20/1		SPARE							0	
10	20/1		SPARE					0			
11	20/1		SPARE						0		
12	20/1		SPARE							0	
VA/PHASE								328.89	25	506.67	
TOTAL [VA]								860.555556			
TOTAL [A]								2			

PNL 3LP-DIM-1, CKT. 1

Total VA = (# D2 Fixtures)*(VA / Fixture)
 Total VA = (12 fixture)(42 VA/fixture) = 507 VA.

PNL 3LP-DIM-1, CKT. 2

Total VA = (# A2 Fixtures)*(VA / Fixture)
 Total VA = (5 fixture)(42 VA/fixture) = 211 VA.

PNL 3LP-DIM-1, CKT. 23

Total VA = (# A2 Fixtures)*(VA / Fixture)
 Total VA = (5 fixture)(42 VA/fixture) = 211 VA.

PNL 3LP-DIM-1, CKT. 34

Total VA = (# A2 Fixtures)*(VA / Fixture)
 Total VA = (5 fixture)(42 VA/fixture) = 211 VA.

PNL 3LP-DIM-1, CKT. 35

Total VA = (# A2 Fixtures)*(VA / Fixture)
 Total VA = (5 fixture)(42 VA/fixture) = 211 VA.

DIMMER PANELBOARD SCHEDULE											
Panel: <u>3LP-DIM-1</u>			BUS: <u>200A</u>			Voltage: <u>208/120</u>					
Location: <u>AUDITORIUM/ STAGE</u>			MCB: <u>-</u>			Phase: <u>3P</u>					
Mounting: <u>SURFACE</u>			AIC: <u>22,000</u>			Wire: <u>4W</u>					
CIRCUIT		CONTROL ZONE	FIXTURE		LAMP			PHASE (W)			REMARKS
NO	BKR		TYPE	QTY	QTY	W	TYPE	A	B	C	
1	20/1	a	D2	12	1	38	FL	507			
2	20/1	c	A2	5	1	38	FL		211		
3	20/1		TTE	1	1	1500				1500	
4	20/1		TTE	1	1	1500		1500			
5	20/1		TTE	1	1	1500			1500		
6	20/1		TTE	1	1	1500				1500	
7	20/1		TTE	1	1	1500		1500			
8	20/1		TTE	1	1	1500			1500		
9	20/1		TTE	1	1	1500				1500	
10	20/1		TTE	1	1	1500		1500			
11	20/1		TTE	1	1	1500			1500		
12	20/1		TTE	1	1	1500				1500	
13	20/1		TTE	1	1	1500		1500			
14	20/1		TTE	1	1	1500			1500		
15	20/1		TTE	1	1	1500				1500	
16	20/1		TTE	1	1	1500		1500			

17	20/1		TTE	1	1	1500			1500		
18	20/1		TTE	1	1	1500				1500	
19	20/1		TTH	2	1	750		1500			
20	20/1		TTH	2	1	750			1500		
21	20/1		TTH	2	1	750				1500	
22	20/1		TTH	2	1	750		1500			
23	20/1	d	A2	5	1	38	FL		211		
24	20/1		TAA	16	1	50				800	
25	20/1		TAA	16	1	50		800			
26	20/1		TTD	1	1	1500			1500		
27	20/1		TTD	1	1	1500				1500	
28	20/1		TTD	1	1	1500		1500			
29	20/1		TTD	1	1	1500			1500		
30	20/1		TTD	1	1	1500				1500	
31	20/1		TTD	1	1	1500		1500			
32	20/1		TTD	1	1	1500			1500		
33	20/1		TTD	1	1	1500				1500	
34	20/1	f	A2	5	1	38	FL	211			
35	20/1	g	A2	5	1	38	FL		211		
36	20/1		SPARE							0	
37	20/1		SPARE					0			
38	20/1		SPARE						0		
39	20/1		SPARE							0	
40	20/1		SPARE					0			
41	20/1		SPARE						0		
42	20/1		SPARE							0	
43	20/1		SPARE					0			
44	20/1		SPARE						0		
45	20/1		SPARE							0	
46	20/1		SPARE					0			
47	20/1		SPARE						0		
48	20/1		SPARE							0	
VA/PHASE								15018	14133	15800	
TOTAL [VA]								44951.11111			
TOTAL [A]								124.9			

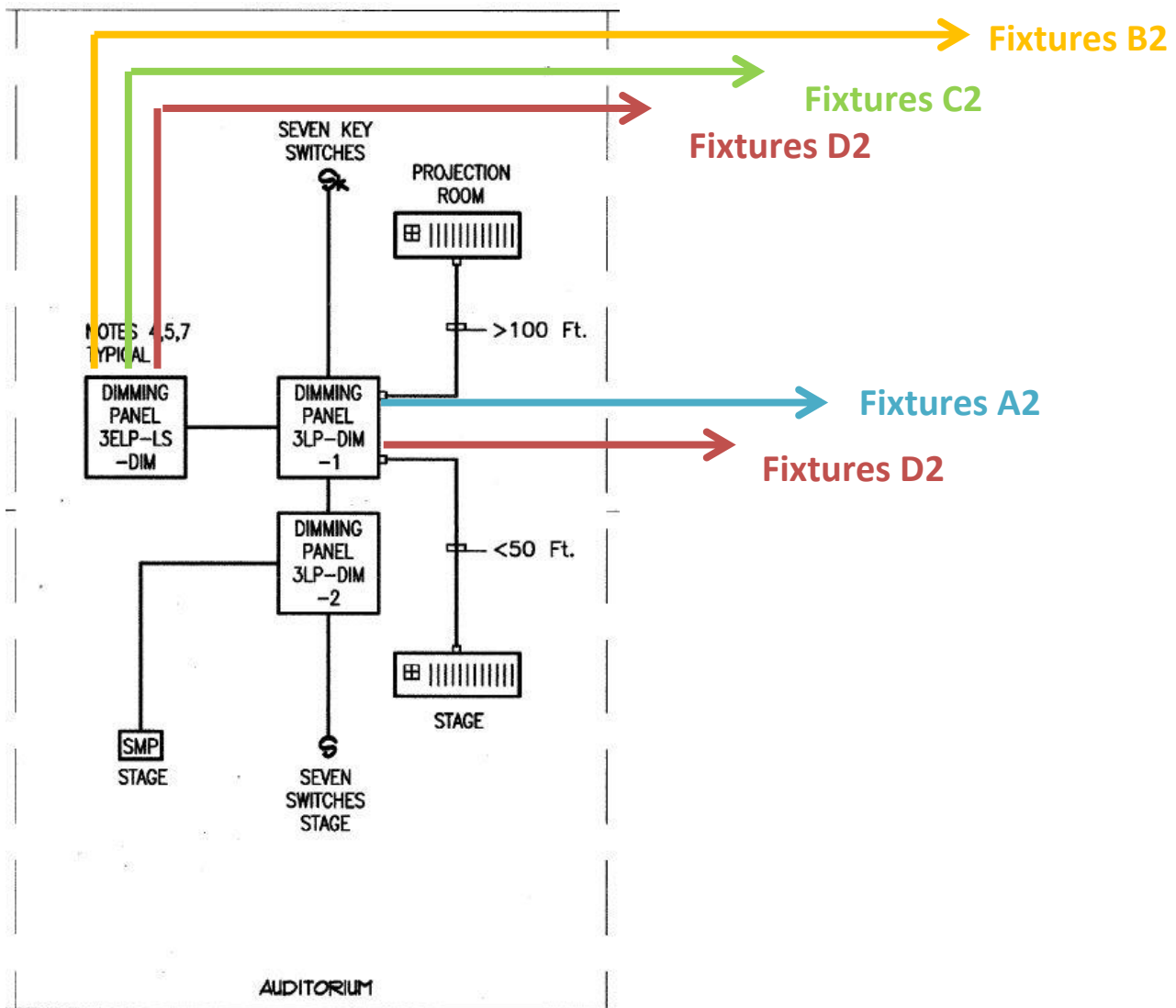
vii. New Dimming wiring diagram

The façade luminaires do not have dimming capabilities.

The Intermediate School Cafeteria luminaires do not have dimming capabilities

The High School Art Room does not have dimming capabilities.

The diagram below shows the dimming wiring diagram for the auditorium. Panels 3LP-DIM-1 and 3LP-DIM-2 are fed from MS2 which is a normal power feed. Panel 3ELP-LS-DIM is fed from 3EDP-LS and is a normal/emergency power feed. The diagram below indicates the fixtures to be fed.



viii. Resize Panelboard Feeder

The table below shows the method with which the spares and spaces were calculated into the feeder sizing. Each spare was taken at 65% of its rating, which came to 13 amps for all of the 20 amp branch circuits. No panelboards had any spaces, so it had no contribution to the overall load.

FEEDER		CONNECTED LOAD	SPARES			SPACES		TOTAL LOAD
TAG	PNL		#	BKR [A]	LOAD [A]	#	LOAD [A]	
1	1ELP-LS	45.53	8	20	13	0	10	149.53
2	1LP-A	42.11	13	20	13	0	10	211.11
3	3LP-DIM1	124.9	13	20	13	0	10	293.9
4	3ELP-DIM	2	8	20	13	0	10	106
5	5LP-A	56.56	11	20	13	0	10	199.56
6	5ELP-LS	15.89	9	20	13	0	10	132.89

The table below shows the feeder schedule for all of the feeders resized feeders.

FEEDER SCHEDULE														
FEEDER INFO				CONDUIT		CONDUCTORS (PER SET)								
				(PER SET)		PHASE CONDUCTORS			NEUTRAL CONDUCTORS			GROUND CONDUCTORS		
TAG	FROM	TO	# SETS	SIZE	TYPE	No.	SIZE	TYPE	No.	SIZE	TYPE	No.	SIZE	TYPE
1	1EDP-LS	1ELP-LS	1	2"	EMT	3	1/0	CU THWN	1	1/0	CU THWN	1	6	CU THWN
2	MS2	1LP-A	1	2 1/2"	EMT	3	4/0	CU THWN	1	4/0	CU THWN	1	4	CU THWN
3	MS2	3LP-DIM1	1	3"	EMT	3	350	CU THWN	1	350	CU THWN	1	4	CU THWN
4	1EDP-LS	3ELP-DIM	1	1 1/2"	EMT	3	2	CU THWN	1	2	CU THWN	1	6	CU THWN
5	MS2	5LP-A	1	2"	EMT	3	3/0	CU THWN	1	3/0	CU THWN	1	6	CU THWN
6	1EDP-LS	5ELP-LS	1	2"	EMT	3	1/0	CU THWN	1	1/0	CU THWN	1	6	CU THWN

The table below is a continuation of the feeder schedule above.

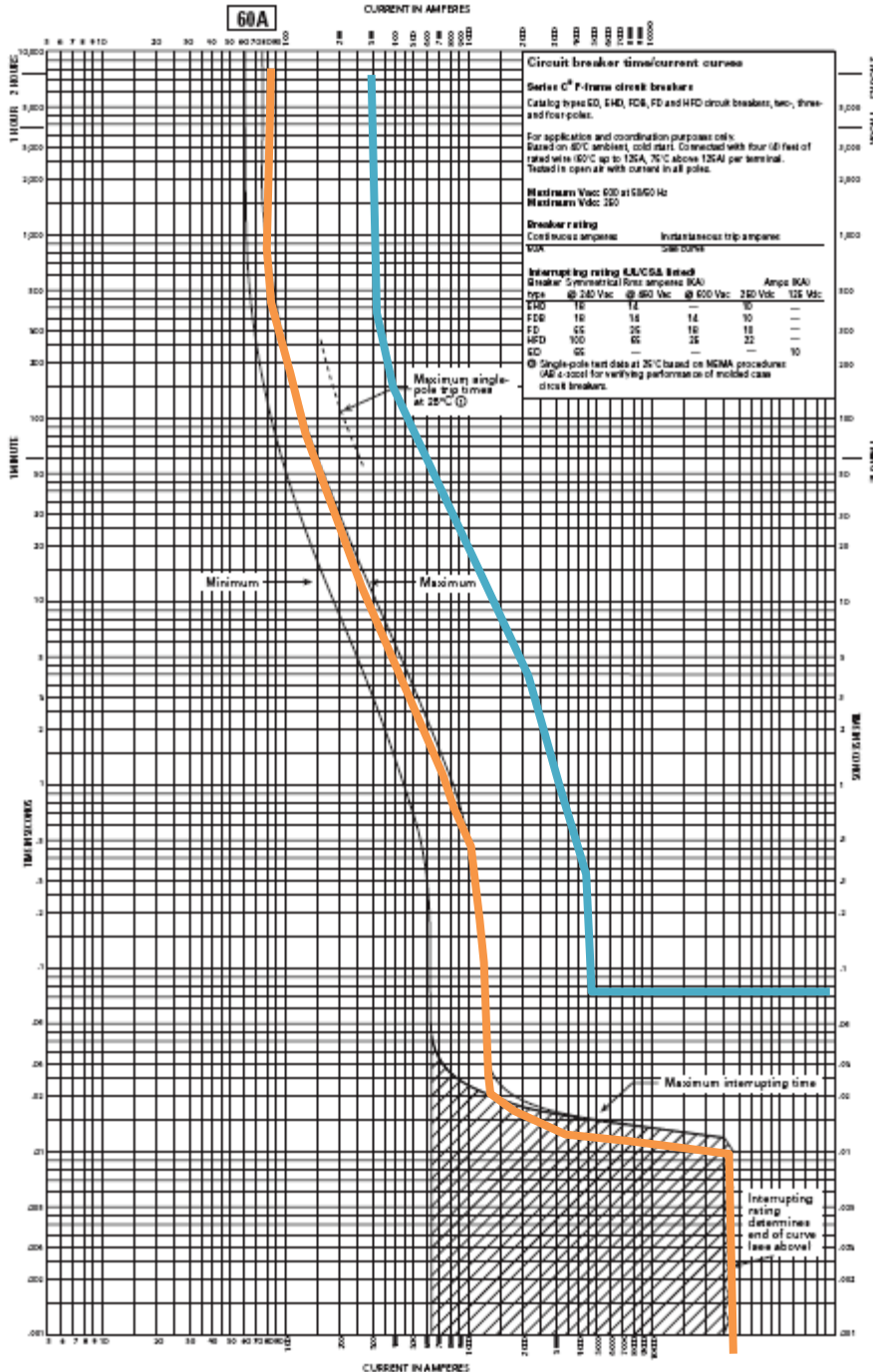
FEEDER SCHEDULE						
FEEDER INFO				SIZE OF	FRAME OR	REMARKS
				OVERCURRENT	SWITCH	
TAG	FROM	TO	# SETS	PROTECTION	SIZE	
1	1EDP-LS	1ELP-LS	1	200	225	
2	MS2	1LP-A	1	225	400	
3	MS2	3LP-DIM1	1	300	400	
4	1EDP-LS	3ELP-DIM	1	110	225	
5	MS2	5LP-A	1	200	225	
6	1EDP-LS	5ELP-LS	1	150	225	

ix. Manufacturer Information

Refer to appendix for manufacturer specification sheets.

2 | Coordination Study / Short Circuit

a. coordination study

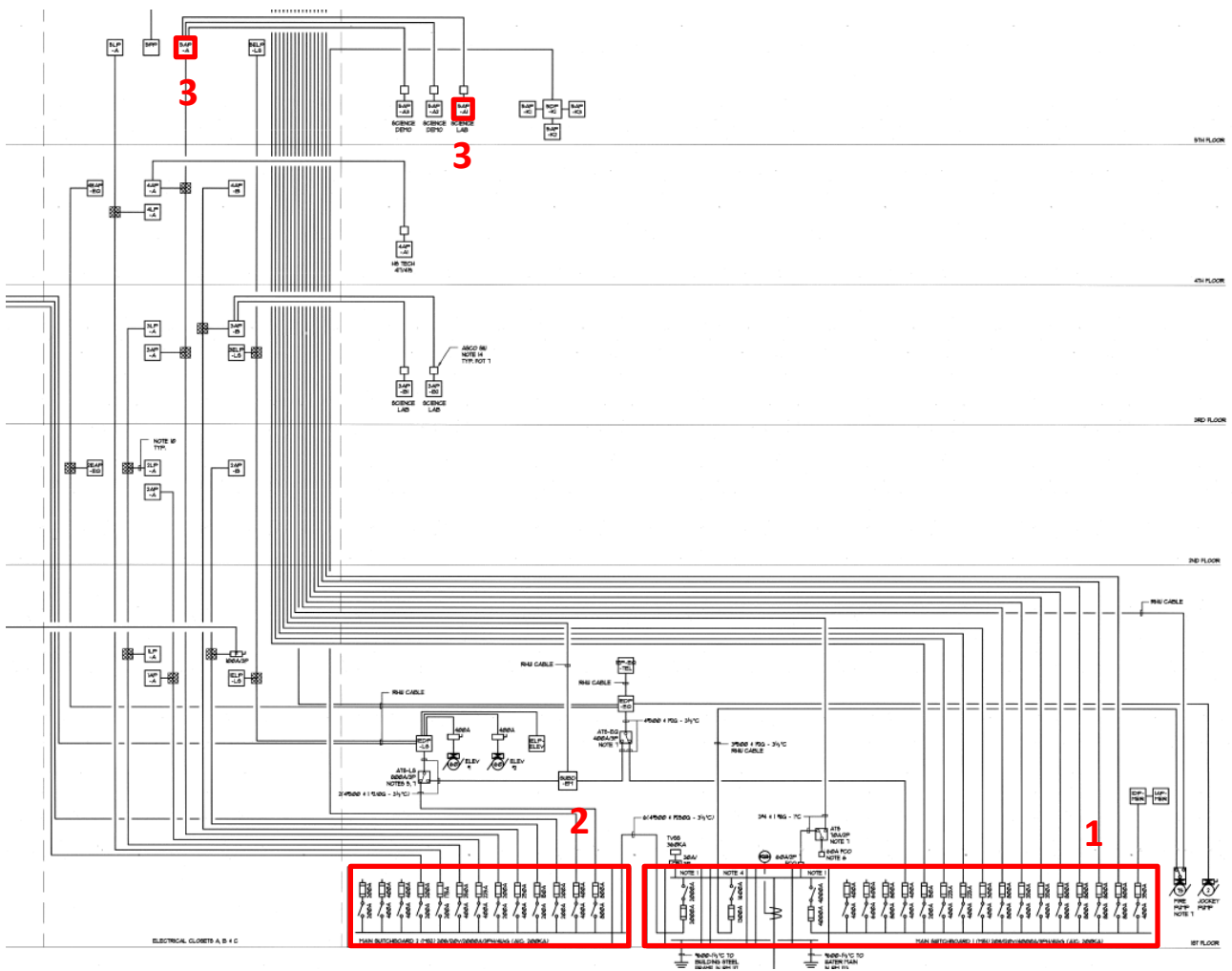


We see here that the 60A time-current curve, represented in orange, is to the left of the time-current curve of the 100A breaker, represented in blue. This means the 60A breaker will trip first. Breakers are properly coordinated.

b. Short circuit calculations

Short-Circuit Calculations														
The following calculations are based on the "Point-by Point" method where:														
Isc = Isc x M		M = 1/(1+f)		$f = \frac{1.732 \times L \times I}{C \times E}$		XFMR: $IP(sca) = \frac{IP(sca) \times Vp \times \%Z}{100,000 \times KVA}$ $IS(sca) = \frac{Vp \times M \times IS(sca)}{Vs}$								
Fault Point	Panel Transformer	Source (Fault Point)	Source I (amps)	Conduit Type	Wire/Bus Size	Wire/Bus Type	'C' value	E (volts)	L (length)	X'FMR KVA	X'FMR Z	f	M	Isc
1	Service	-	42,000											42000
2	MS1	1	42000	M	12 Set(s) of 500 KCML	CU	22185	208	20			0.026	0.97	40925
3	MS2	2	40925	M	6 Set(s) of 500 KCML	CU	22185	208	20			0.051	0.95	38931
4	5AP-A	3	38931	M	1 Set(s) of 3	CU	4760	208	100			6.810	0.13	4985
5	5AP-A1	4	4985	M	1 Set(s) of 3	CU	4760	208	30			0.262	0.79	3951

The previous table shows the short circuit current rating for the path through the electrical system as indicated below.



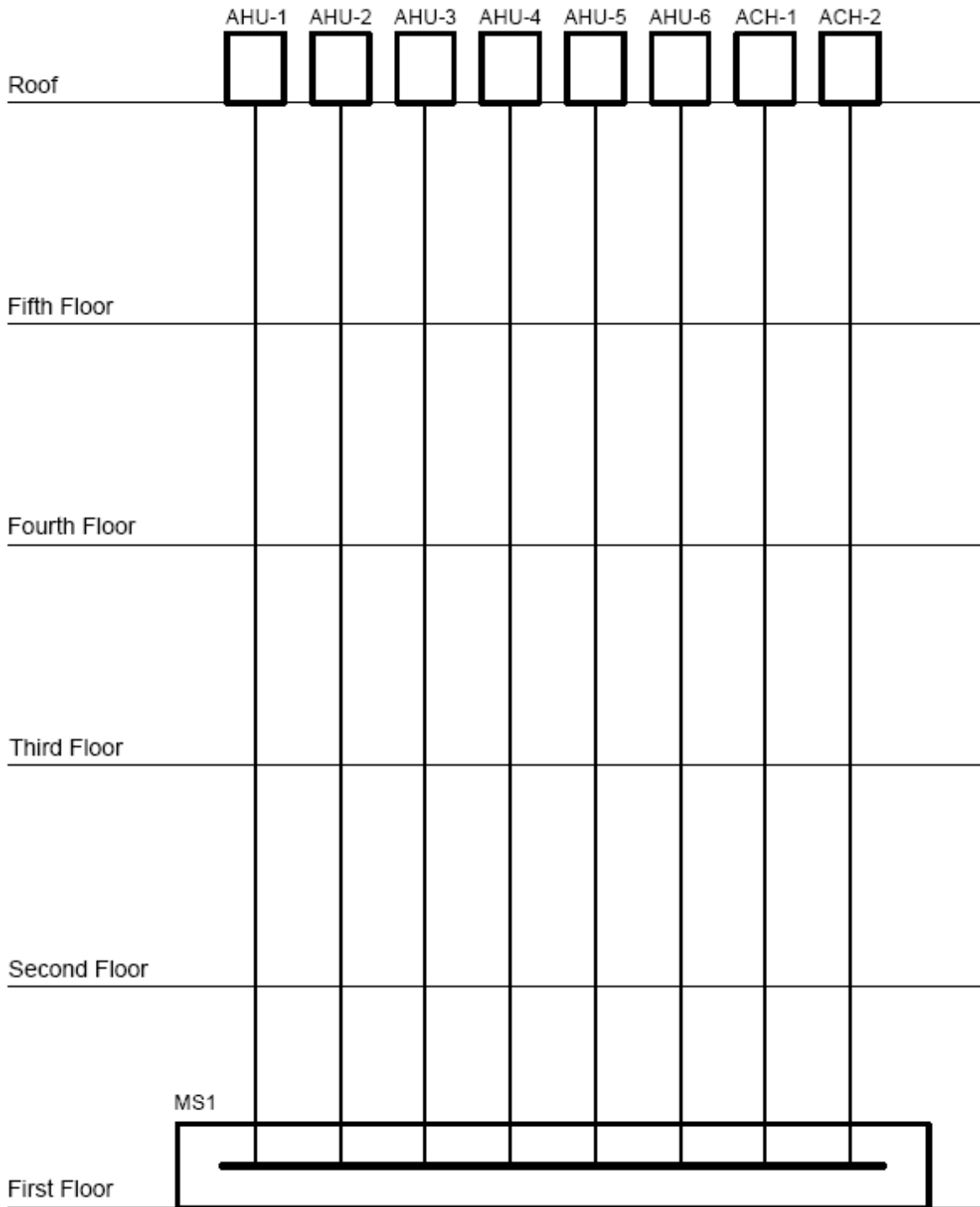
3 | depth topic 1 | Electrical Distribution

This depth topic will analyze the (assumed) cost savings incurred by altering the method with which the rooftop mechanical equipment is served. The existing rooftop mechanical equipment is served, individually, from the main service switchboard, which is located on the first floor. The goal of this depth is to show that money can be saved by running a single feed to the roof (as opposed to the seven that are currently in place) feeding a distribution panel. It is from this distribution panel that each piece of mechanical equipment will be served. Savings are assumed to come from the use of less material (wire and conduit) as well as the (reduced) amount of labor-hours required to install the system. In addition, the single feed running to the roof (from the first floor) will hit a transformer before feeding the rooftop distribution panel. The reason for this is that the entire electrical system is currently operating at 208/120V. Additional savings can be produced by increasing the voltage, and thus, decreasing the size of the wire feeding the mechanical equipment.

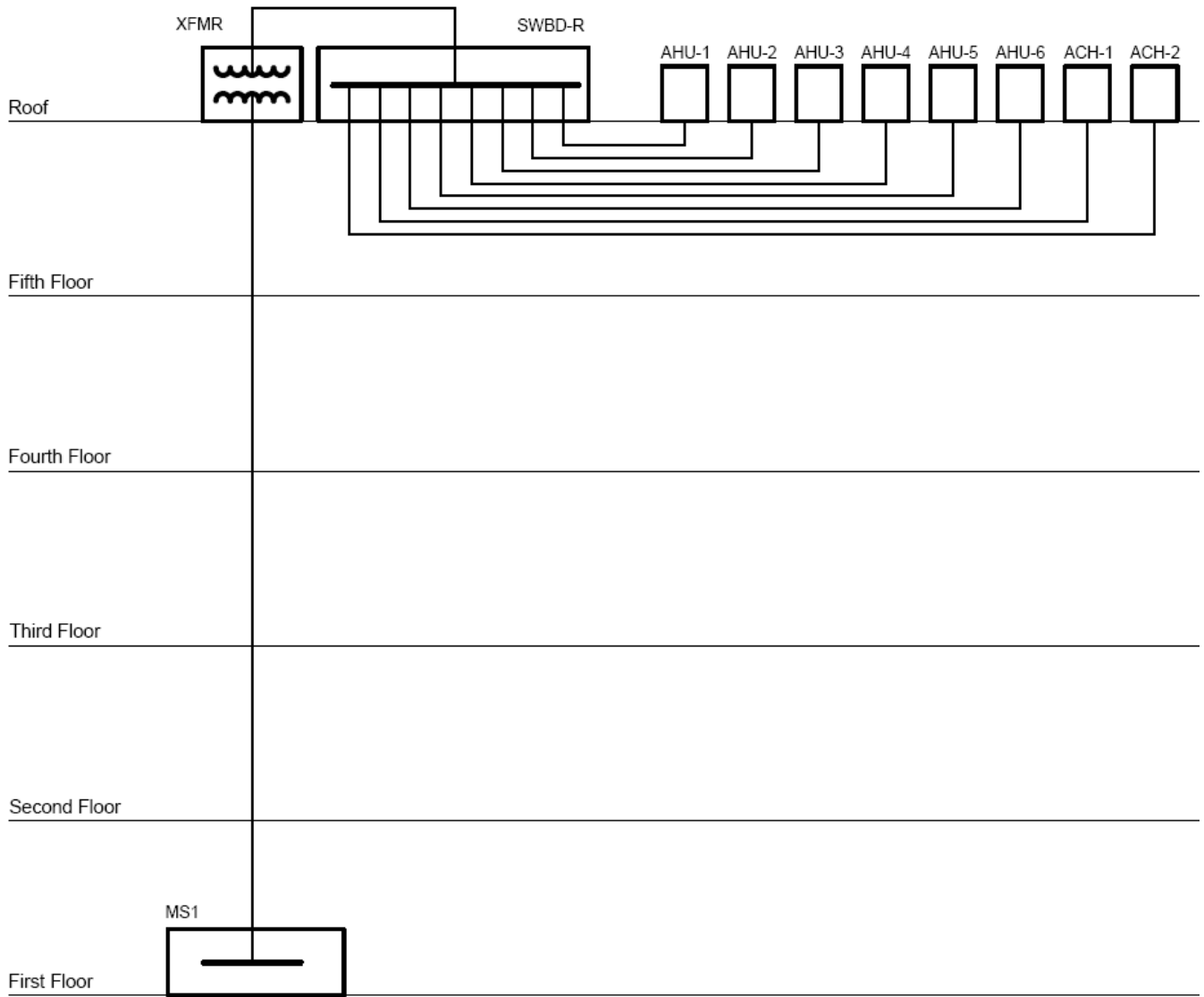
Below is a list of **assumptions** that have been made during this analysis:

- All existing wire is stranded copper, THWN
- All proposed wire is stranded aluminum, THWN
- All electrical cost data was taken from RS Means 2010
- RS Means Conduit prices include 2 terminations, 2 elbows, 11 beam clamps, and 11 couplings per 100 LF
 - It was assumed that these inclusions were sufficient, and none were added in addition
- Pull boxes are NEMA 1, sheet metal, 12"x12"x6"
- Hanger price includes, hanger, bolt, and 12" rod
- Hanger estimates include only standard hangers, no specialty hangers included

Below is a schematic diagram showing the **EXISTING** distribution method:



Below is a schematic diagram showing the **PROPOSED** distribution method:

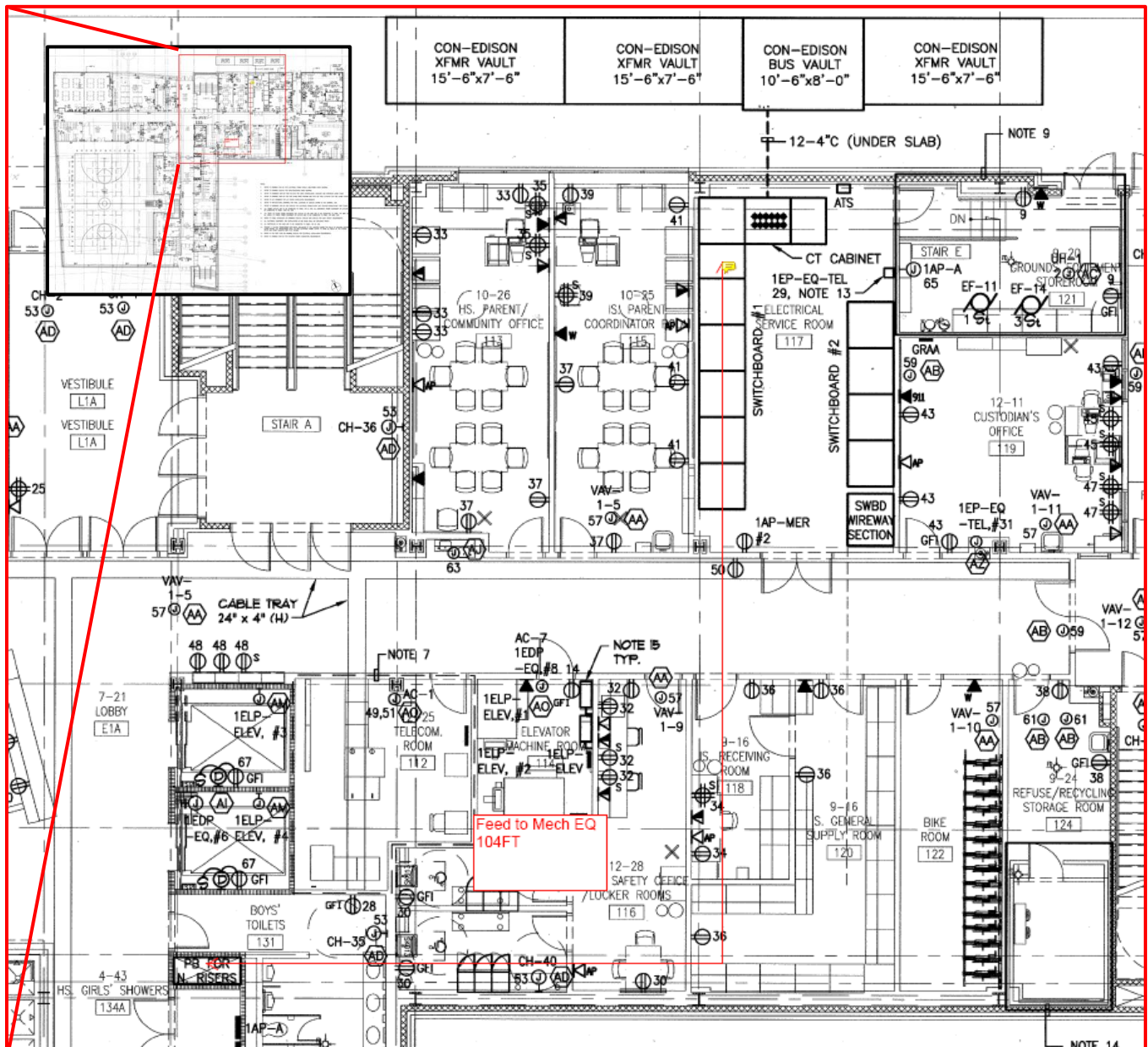


Existing System

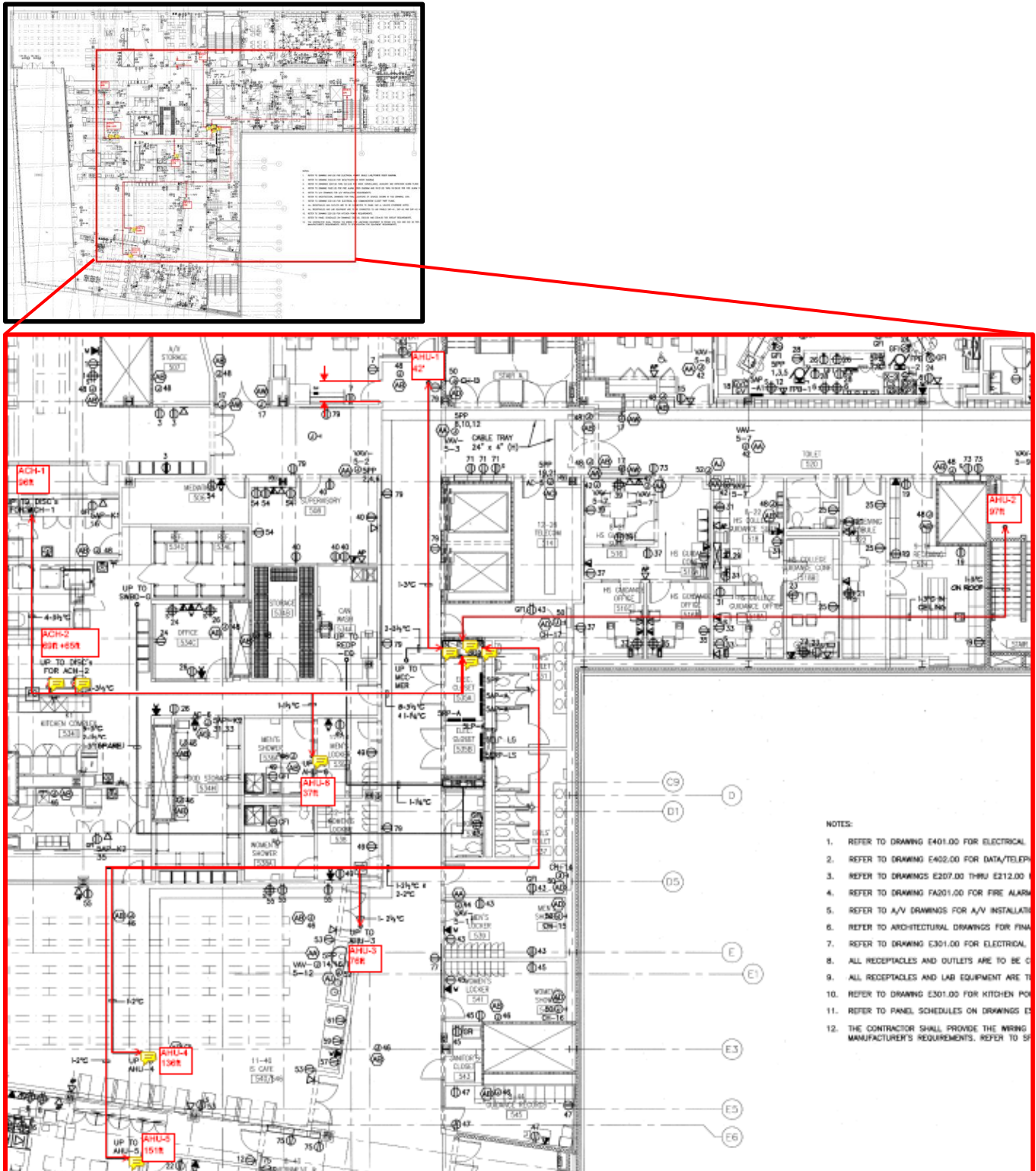
The first step to calculating the total cost of the existing electrical distribution of the rooftop mechanical equipment is to calculate to total run length of the existing wire and conduit. This includes:

1. The horizontal run on the first floor from the main distribution panel MS1 to the conduit riser near the first floor electrical closet
2. The vertical distance travelled up the conduit riser to the fifth floor
3. The horizontal run on the fifth floor to the respective mechanical equipment poke-thru's

The plan below shows the horizontal run from the main distribution panel, MS1, to the electrical riser near the first floor electrical closet. This corresponds to the bullet-point 1.



The plan below shows the horizontal conduit runs to each piece of mechanical equipment in the ceiling of the 5th floor. The runs start at the 5th floor electric closet and terminate at the poke-thru up to each piece of equipment. The calculated horizontal runs shown in the large plan below corresponds to bullet point 3 from the previous page. The small plan shows the location of the blown up portion relative to the entire floor plan.



The tables below show important information for which the electrical cost estimate was based. This information includes, but is not limited to, the following:

- Total run length, including vertical and horizontal runs
- Required installation equipment, including elbows, couplings, pull boxes, and conduit hangers

QUANTITIES							
EQ	RUN LENGTH			EQUIPMENT			
	HORIZ (FT)	VERT (FT)	TOTAL (FT)	ELBOW	COUPLING	PULL BOX	HANGER
AHU-1	146	80	226	5	10	1	75
AHU-2	201	80	281	6	12	2	94
AHU-3	180	80	260	6	12	1	87
AHU-4	240	80	320	6	12	0	107
AHU-5	255	80	335	6	12	0	112
AHU-6	141	80	221	6	12	1	74
ACH-1/A	200	80	280	5	10	1	93
ACH-1/B	200	80	280	5	10	0	93
ACH-2/A	238	80	318	6	12	1	106
ACH-2/B	238	80	318	6	12	1	106

The table below includes information regarding the feeder and protective device (all fused switches) for each piece of rooftop mechanical equipment. Cost information taken from RS Means 2010 were based on the feeder and protective device information shown below.

FEEDER AND PROCTIVE DEVICE								
EQ	PROTECTIVE DEVICE			FEEDER				
	AF	AT	WIRE/ SET	SETS	WIRE SIZE	COND SIZE	NUETR SIZE	GND SIZE
AHU-1	400	350	3	1	500	3"	-	3
AHU-2	400	350	3	1	500	3"	-	3
AHU-3	400	300	3	1	350	2 1/2"	-	3
AHU-4	400	225	3	1	4/0	2	-	4
AHU-5	400	225	3	1	4/0	2	-	4
AHU-6	200	150	3	1	1/0	1 1/2"	-	6
ACH-1/A	800	800	4	1	500	3 1/2"	500	2/0
ACH-1/B	800	800	4	1	500	3 1/2"	500	2/0
ACH-2/A	800	800	4	1	500	3 1/2"	500	2/0
ACH-2/B	800	800	4	1	500	3 1/2"	500	2/0

MATERIAL COST CALCULATION												
EQ	FEEDER					MATERIAL PRICE						
	SETS	WIRE SIZE	COND SIZE	NUETR SIZE	GND SIZE	WIRE (\$/Ft)	COND (\$/Ft)	NUETR (\$/Ft)	GND (\$/Ft)	PULL BOX (\$/EA.)	HANGER (\$/EA.)	TOTAL
AHU-1	1	500	3"	-	3	9.6	13.25	0	1.07	37.00	10.15	\$10,546.75
AHU-2	1	500	3"	-	3	9.6	13.25	0	1.07	37.00	10.15	\$13,141.44
AHU-3	1	350	2 1/2"	-	3	6.95	11.15	0	1.07	37.00	9.55	\$9,462.87
AHU-4	1	4/0	2"	-	4	4.2	4.67	0	0.87	37.00	8.75	\$6,736.53
AHU-5	1	4/0	2"	-	4	4.2	4.67	0	0.87	37.00	8.75	\$7,052.31
AHU-6	1	1/0	1 1/2"	-	6	2.11	3.59	0	0.55	37.00	6.50	\$2,828.60
ACH-1/A	2	500	3 1/2"	500	2/0	9.6	16.80	9.60	2.65	37.00	12.10	\$34,728.67
ACH-1/B	2	500	3 1/2"	500	2/0	9.6	16.80	9.60	2.65	37.00	12.10	\$34,654.67
ACH-2/A	2	500	3 1/2"	500	2/0	9.6	16.80	9.60	2.65	37.00	12.10	\$39,431.80
ACH-2/B	2	500	3 1/2"	500	2/0	9.6	16.80	9.60	2.65	37.00	12.10	\$39,431.80
TOTAL												\$198,015.43

The previous table shows the material prices (taken from RS Means 2010 Electrical Cost Data), and calculated price of feeding each piece of equipment.

The formula used to calculate the cost of feeding the equipment is as follows:

$$\text{Total Cost (\$)} = (\text{Number of wire sets}) * [(3 * \text{Wire Cost} * \text{Run Length}) + (\text{Conduit Cost} * \text{Run Length}) + (\text{Neutral Cost} * \text{Run Length}) + (\text{Ground Cost} * \text{Run Length}) + (\text{Pullbox Cost} * \text{QTY}) + (\text{Hanger Cost} * \text{QTY})]$$

The total material cost for the rooftop mechanical equipment is **\$198,015.43**.

LABOR COST CALCULATION												
EQ	FEEDER					LABOR PRICE						
	SETS	WIRE SIZE	COND SIZE	NUETR SIZE	GND SIZE	WIRE (\$/Ft)	COND (\$/Ft)	NUETR (\$/Ft)	GND (\$/Ft)	PULL BOX (\$/EA.)	HANGER (\$/EA.)	TOTAL
AHU-1	1	500	3"	-	3	2.45	7.85	0	0.79	75.50	6.55	\$4,181.54
AHU-2	1	500	3"	-	3	2.45	7.85	0	0.79	75.50	6.55	\$5,256.30
AHU-3	1	350	2 1/2"	-	3	2.18	6.55	0	0.79	75.50	4.90	\$4,107.67
AHU-4	1	4/0	2"	-	4	1.78	4.90	0	0.74	75.50	3.92	\$3,931.73
AHU-5	1	4/0	2"	-	4	1.78	4.90	0	0.74	75.50	3.92	\$4,116.03
AHU-6	1	1/0	1 1/2"	-	6	1.19	4.36	0	0.61	75.50	3.56	\$2,223.99
ACH-1/A	2	500	3 1/2"	500	2/0	2.45	8.70	2.45	1.35	75.50	8.70	\$12,891.00
ACH-1/B	2	500	3 1/2"	500	2/0	2.45	8.70	2.45	1.35	75.50	8.70	\$12,740.00
ACH-2/A	2	500	3 1/2"	500	2/0	2.45	8.70	2.45	1.35	75.50	8.70	\$14,620.00
ACH-2/B	2	500	3 1/2"	500	2/0	2.45	8.70	2.45	1.35	75.50	8.70	\$14,620.00
TOTAL												\$78,688.27

The below table shows the labor prices (taken from RS Means 2010 Electrical Cost Data), and the calculated labor cost of feeding each piece of equipment. The total labor cost for the existing rooftop mechanical equipment is **\$78,688.27**.

Total Cost = (Material Cost) + (Labor Cost) = \$198,015.43+ \$78,688.27= **\$276,703.70**

The total cost for the **EXISTING** service of the rooftop mechanical equipment is **\$276,703.70**.

Proposed System

The goal, obviously aimed at reducing the cost of the system, will feed a single switchboard located on the roof. This will reduce the number of feeds to the roof (from 8 to 1) where savings will be incurred through material and labor. It is then from this switchboard that all mechanical equipment on the roof will be fed.

Steps to calculating the cost of the proposed system:

1. Convert the mechanical equipment load from a voltage of 208/120 to 480/277
2. Determine the feasibility of using a transformer to step up the voltage from 208/120 to 480/277
 - a. Calculate the total cost (material + labor) for the feeds from the rooftop switchboard (tag: SWDB-R) to each piece of mechanical equipment.
 - b. Do the cost savings incurred from the reduced wire sizes (as a result of raising the voltage) cover the cost of the transformer?
3. Calculate the total cost (material and labor) for the (single) feed from the main switchboard on the first floor, to the rooftop transformer or switchboard (depending on the outcome of step 2).
4. Determine the cost of the rooftop switchboard (material + labor)
5. Add all cost data together to calculate the total cost

Step 1: Calculate load 480/277 volts

The table below shows the calculation of the mechanical equipment loads at a voltage of 480/277 volts. The HP for the motors of the air handling units, taken from the switchboard MS1 that feeds them, was used to calculate the equipment load using **table 430.250** in NFPA70 NEC 2011. For the chillers, the load was given in kVA. Using this, the load, in amps, was found for a voltage of 480/277V. The loads for both voltages are highlighted in blue below.

EQ	LOAD				FEEDER (208V)					FEEDER (480V)				
	kVA	HP	A (208V)	A (480V)	SETS	WIRE	COND	NEUTR	GRD	SETS	WIRE	COND	NEUTR	GRD
AHU-1	-	100	273	124	1	500	3	-	2	1	2/0	2	-	4
AHU-2	-	100	273	124	1	500	3	-	2	1	2/0	2	-	4
AHU-3	-	75	211	96	1	300	2 1/2	-	2	1	1	1 1/4	-	6
AHU-4	-	60	169	77	1	4/0	2	-	4	1	2	1 1/4	-	6
AHU-5	-	60	169	77	1	4/0	2	-	4	1	2	1 1/4	-	6
AHU-6	-	40	114	52	1	4	1	-	4	1	4	1	-	8
ACH-1/A	210	-	583	253	2	500	3	500	2/0	1	400	3	400	1
ACH-1/B	220	-	611	265	2	500	3	500	3/0	1	400	3	400	1
ACH-2/A	210	-	583	253	2	500	3	500	2/0	1	400	3	400	1
ACH-2/B	220	-	611	265	2	500	3	500	3/0	1	400	3	400	1

	208/120 V	480/277 V
Total A:	3598	1585
Total kVA:	2990	1317

Step 2: Determine the feasibility of including a transformer

To determine the feasibility of using a transformer, the run length from the switchboard to the mechanical equipment must be calculated. This includes both horizontal and vertical runs. In addition the quantity of additions items, such as elbows, couplings, pullboxes, and hangers needs to be determined. The figure below shows this information for the feed from the rooftop switchboard SWBD-R to each piece of rooftop mechanical equipment.

QUANTITIES								
FEEDER		RUN LENGTH			EQUIPMENT			
FROM	TO	HORIZ (FT)	VERT (FT)	TOTAL (FT)	ELBOW	COUPLING	PULL BOX	HANGER
SWBD-R	AHU-1	48	20	68	3	6	1	23
SWBD-R	AHU-2	125	20	145	3	6	1	48
SWBD-R	AHU-3	75	20	95	3	6	1	32
SWBD-R	AHU-4	72	20	92	3	6	1	31
SWBD-R	AHU-5	100	20	120	3	6	1	40
SWBD-R	AHU-6	28	20	48	3	6	1	16
SWBD-R	ACH-1/A	50	20	70	3	6	1	23
SWBD-R	ACH-1/B	50	20	70	3	6	1	23
SWBD-R	ACH-2/A	60	20	80	3	6	1	27
SWBD-R	ACH-2/B	60	20	80	3	6	1	27

MATERIAL COST CALCULATION: 480/277 V													
RUN		FEEDER (480V)					MATERIAL PRICE						
FROM	TO	NUMBER OF SETS	WIRE SIZE	COND SIZE	NUETR SIZE	GRD SIZE	WIRE (\$/Ft)	COND (\$/Ft)	NUETR (\$/Ft)	GND (\$/Ft)	PULL BOX (\$/EA.)	HANGER (\$/EA.)	TOTAL
SWBD-R	AHU-1	1	2/0	2	-	4	0.775	4.67	0	0.275	37.00	3.07	\$600.95
SWBD-R	AHU-2	1	2/0	2	-	4	0.775	4.67	0	0.275	37.00	3.07	\$1,239.53
SWBD-R	AHU-3	1	1	1 1/4	-	6	0.545	2.77	0	0.22	37.00	2.33	\$550.16
SWBD-R	AHU-4	1	2	1 1/4	-	6	0.375	2.77	0	0.22	37.00	2.33	\$487.03
SWBD-R	AHU-5	1	2	1 1/4	-	6	0.375	2.77	0	0.22	37.00	2.33	\$624.00
SWBD-R	AHU-6	1	4	1	-	8	0.275	1.70	0	0.22	37.00	2.08	\$202.04
SWBD-R	ACH-1/A	1	400	3	400	1	2.14	13.25	2.14	0.545	37.00	3.75	\$1,689.35
SWBD-R	ACH-1/B	1	400	3	400	1	2.14	13.25	2.14	0.545	37.00	3.75	\$1,689.35
SWBD-R	ACH-2/A	1	400	3	400	1	2.14	13.25	2.14	0.545	37.00	3.75	\$1,925.40
SWBD-R	ACH-2/B	1	400	3	400	1	2.14	13.25	2.14	0.545	37.00	3.75	\$1,925.40
TOTAL													\$10,933.21

The previous table shows the total **MATERIAL** cost for the feeds to the mechanical equipment from the rooftop switchboard SWBD-R at a voltage of **480/277 volts**. The total cost for these feeds is **\$10,933.21**.

LABOR COST CALCULATION: 480/277 V													
RUN		FEEDER					LABOR PRICE						
FROM	TO	NUMBER OF SETS	WIRE SIZE	COND SIZE	NUETR SIZE	GRD SIZE	WIRE (\$/Ft)	COND (\$/Ft)	NUETR (\$/Ft)	GND (\$/Ft)	PULL BOX (\$/EA.)	HANGER (\$/EA.)	TOTAL
SWBD-R	AHU-1	1	2/0	2	-	4	1.09	4.90	0	0.61	37.00	1.47	\$667.02
SWBD-R	AHU-2	1	2/0	2	-	4	1.09	4.90	0	0.61	37.00	1.47	\$1,380.43
SWBD-R	AHU-3	1	1	1 1/4	-	6	0.87	3.92	0	0.49	37.00	0.98	\$734.93
SWBD-R	AHU-4	1	2	1 1/4	-	6	0.74	3.92	0	0.49	37.00	0.98	\$677.01
SWBD-R	AHU-5	1	2	1 1/4	-	6	0.74	3.92	0	0.49	37.00	0.98	\$871.80
SWBD-R	AHU-6	1	4	1	-	8	0.61	3.41	0	0.49	37.00	3.01	\$359.48
SWBD-R	ACH-1/A	1	400	3	400	1	1.70	7.85	1.70	0.87	37.00	2.45	\$1,180.57
SWBD-R	ACH-1/B	1	400	3	400	1	1.70	7.85	1.70	0.87	37.00	2.45	\$1,180.57
SWBD-R	ACH-2/A	1	400	3	400	1	1.70	7.85	1.70	0.87	37.00	2.45	\$1,343.93
SWBD-R	ACH-2/B	1	400	3	400	1	1.70	7.85	1.70	0.87	37.00	2.45	\$1,343.93
TOTAL													\$9,739.67

The previous table shows the total **LABOR** cost for the feeds to the mechanical equipment from the rooftop switchboard SWBD-R at a voltage of **480/277 volts**. The total cost for these feeds is **\$9,739.67**.

MATERIAL COST CALCULATION: 208/120 V													
RUN		FEEDER					MATERIAL PRICE						
FROM	TO	NUMBER OF SETS	WIRE SIZE	COND SIZE	NUETR SIZE	GRD SIZE	WIRE (\$/Ft)	COND (\$/Ft)	NUETR (\$/Ft)	GND (\$/Ft)	PULL BOX (\$/EA.)	HANGER (\$/EA.)	TOTAL
SWBD-R	AHU-1	1	500	3	-	2	2.36	13.25	0	0.375	37.00	3.75	\$1,529.94
SWBD-R	AHU-2	1	500	3	-	2	2.36	13.25	0	0.375	37.00	3.75	\$3,220.48
SWBD-R	AHU-3	1	300	2 1/2	-	2	1.8	11.15	0	0.375	37.00	3.51	\$1,756.03
SWBD-R	AHU-4	1	4/0	2	-	4	1.07	4.67	0	0.275	37.00	3.07	\$881.41
SWBD-R	AHU-5	1	4/0	2	-	4	1.07	4.67	0	0.275	37.00	3.07	\$1,138.40
SWBD-R	AHU-6	1	4	1	-	4	0.275	1.70	0	0.275	37.00	2.08	\$204.68
SWBD-R	ACH-1/A	2	500	3	500	2/0	2.36	13.25	2.36	0.775	37.00	3.75	\$3,534.10
SWBD-R	ACH-1/B	2	500	3	500	3/0	2.36	13.25	2.36	0.960	37.00	3.75	\$3,560.00
SWBD-R	ACH-2/A	2	500	3	500	2/0	2.36	13.25	2.36	0.775	37.00	3.75	\$4,028.40
SWBD-R	ACH-2/B	2	500	3	500	3/0	2.36	13.25	2.36	0.960	37.00	3.75	\$4,058.00
TOTAL													\$23,911.43

The previous table shows the total **MATERIAL** cost for the feeds to the mechanical equipment from the rooftop switchboard SWBD-R at a voltage of **208/120 volts**. The total cost for these feeds is **\$23,911.43**.

LABOR COST CALCULATION: 208/120 V													
RUN		FEEDER (208V)					LABOR PRICE						
FROM	TO	NUMBER OF SETS	WIRE SIZE	COND SIZE	NUETR SIZE	GRD SIZE	WIRE (\$/Ft)	COND (\$/Ft)	NUETR (\$/Ft)	GND (\$/Ft)	PULL BOX (\$/EA.)	HANGER (\$/EA.)	TOTAL
SWBD-R	AHU-1	1	500	3	-	2	1.96	7.85	0	0.74	37.00	2.45	\$1,076.49
SWBD-R	AHU-2	1	500	3	-	2	1.96	7.85	0	0.74	37.00	2.45	\$2,253.57
SWBD-R	AHU-3	1	300	2 1/2	-	2	1.45	6.55	0	0.74	37.00	1.47	\$1,189.35
SWBD-R	AHU-4	1	4/0	2	-	4	1.26	4.90	0	0.61	37.00	1.47	\$936.30
SWBD-R	AHU-5	1	4/0	2	-	4	1.26	4.90	0	0.61	37.00	1.47	\$1,210.00
SWBD-R	AHU-6	1	4	1	-	4	0.61	3.41	0	0.61	37.00	3.01	\$365.00
SWBD-R	ACH-1/A	2	500	3	500	2/0	1.96	7.85	1.96	1.09	37.00	2.45	\$2,537.53
SWBD-R	ACH-1/B	2	500	3	500	3/0	1.96	7.85	1.96	1.19	37.00	2.45	\$2,551.53
SWBD-R	ACH-2/A	2	500	3	500	2/0	1.96	7.85	1.96	1.09	37.00	2.45	\$2,889.47
SWBD-R	ACH-2/B	2	500	3	500	3/0	1.96	7.85	1.96	1.19	37.00	2.45	\$2,905.47
TOTAL													\$17,914.71

The previous table shows the total **LABOR** cost for the feeds to the mechanical equipment from the rooftop switchboard SWBD-R at a voltage of **208/120 volts**. The total cost for these feeds is **\$7,914.71**.

All cost calculations presented in the previous four tables were performed based on the following formula:

$$\text{Total Cost (\$)} = (\text{Number of wire sets}) * [(3 * \text{Wire Cost} * \text{Run Length}) + (\text{Conduit Cost} * \text{Run Length}) + (\text{Neutral Cost} * \text{Run Length}) + (\text{Ground Cost} * \text{Run Length}) + (\text{Pullbox Cost} * \text{QTY}) + (\text{Hanger Cost} * \text{QTY})]$$

The table below summarizes the data from the previous four cost calculation tables. As shown, a savings of **\$21,153.26** (\$41,826.14 – \$20,672.88) is produced by serving the mechanical equipment at a voltage of 480/277V as opposed to the original voltage of 208/120V. However, because the total price (material + labor + equipment) for an appropriately sized transformer is **\$42,055.00**, using a transformer would ultimately produce a loss of **\$20,901.74** (\$21,153.26 - \$42,055.00).

As such, the use of the transformer has been eliminated. The proposed system will consist of a single feed running to the rooftop switchboard SWBD-R, which will supply the feeds to all of the mechanical equipment. No transformer is included.

	208/120 V	480/277 V
Material	\$23,911.43	\$10,933.21
Labor	\$17,914.71	\$9,739.67
Total:	\$41,826.14	\$20,672.88

Step 3: cost for feed from MS1 to rooftop switchboard SWBD-R

The next step in calculating the total cost of the proposed system is to determine the cost of the feed from the main switchboard MS1 located on the first floor, up to the rooftop switchboard SWBD-R. It is important to note that this is a single feed up to the roof, where the existing system has multiple feeds—one for each piece of mechanical equipment.

To do this, quantity information is needed. The table below shows the total run length, vertical an horizontal, for the feed from MS1 to SWBD-R. The vertical run includes the height through the five floors of electrical raceway space, as well as extra length for terminations and poke-thru distances.

QUANTITIES								
FEEDER		RUN LENGTH			EQUIPMENT			
FROM	TO	HORIZ (FT)	VERT (FT)	TOTAL (FT)	ELBOW	COUPLING	PULL BOX	HANGER
MS1	SWBD-R	60	80	140	5	10	1	47

MATERIAL COST CALCULATION													
RUN		FEEDER (480V)					MATERIAL PRICE						
FROM	TO	NUMBER OF SETS	WIRE SIZE	COND SIZE	NUETR SIZE	GRD SIZE	WIRE (\$/Ft)	COND (\$/Ft)	NUETR (\$/Ft)	GND (\$/Ft)	PULL BOX (\$/EA.)	HANGER (\$/EA.)	TOTAL
MS1	SWBD-R	4	500	3	500	1/0	2.36	13.25	2.36	0.655	37	3.75	\$13,921.20

The previous table shows the total **MATERIAL** cost for the feed to the rooftop switchboard SWBD-R from MS1 on the first floor. The total cost for this feed is **\$13,921.20**.

LABOR COST CALCULATION													
RUN		FEEDER					LABOR PRICE						
FROM	TO	NUMBER OF SETS	WIRE SIZE	COND SIZE	NUETR SIZE	GRD SIZE	WIRE (\$/Ft)	COND (\$/Ft)	NUETR (\$/Ft)	GND (\$/Ft)	PULL BOX (\$/EA.)	HANGER (\$/EA.)	TOTAL
MS1	SWBD-R	4	500	3	500	1/0	1.96	7.85	1.96	0.98	37.00	2.45	\$9,940.53

The previous table shows the total **LABOR** cost for the feed to the rooftop switchboard SWBD-R from MS1 on the first floor. The total cost for this feed is **\$9,940.53**.

Step 4: Determine the price of rooftop switchboard SWBD-R

The image below is a tabulation of cost information taken from RS Means 2010 for a 1600A, aluminum bus switchboard. The total cost (material + labor) for the switchboard is **\$5,475.00**.

SWBD-R		
INFO	TAG	SWBD-R
	BUS	ALUMINUM
	RATING	1600A
COST	MATERIAL	\$4,275.00
	LABOR	\$1,200.00
	TOTAL	\$5,475.00

Step 5: Calculate the total cost savings

The last step in calculating the total cost of the proposed system is to add the cost of the individual components of the (proposed) system.

The table below shows a tabulated summary of each individual component of the proposed system. The prices for each component are broken into material and labor costs.

PROPOSED SYSTEM PRICE CALCULATION			
PROPOSED	FEED FROM MS1 TO SWBD-R	MATERIAL	\$ 13,921.20
		LABOR	\$ 9,940.53
	FEED FROM SWBD-R TO EQUIP.	MATERIAL	\$ 23,911.43
		LABOR	\$ 17,914.71
	1600A SWBD PRICE	MATERIAL	\$ 4,275.00
		LABOR	\$ 1,200.00
	TOTAL:		\$ 71,162.87

The total cost can be calculated via the following formula:

$$\text{Total Cost} = (\text{Total Material Cost}) + (\text{Total Labor Cost}) = \$42,107.63 + \$29,055.24 = \mathbf{\$71,162.87}$$

The total cost for the **PROPOSED** service of the rooftop mechanical equipment is **\$71,162.87**.

Conclusion

The table below shows a summary comparison for both the existing system as well as the proposed system, split into material and labor prices. The existing system, costing **\$276,703.70**, cost significantly more than the proposed system costing **\$71,162.87**.

COMPARISON			
EXISTING	FEED FROM MS1 TO EQUIP.	MATERIAL	\$ 198,015.43
		LABOR	\$ 78,688.27
	TOTAL:		\$ 276,703.70
PROPOSED	FEED FROM MS1 TO SWBD-R	MATERIAL	\$ 13,921.20
		LABOR	\$ 9,940.53
	FEED FROM SWBD-R TO EQUIP.	MATERIAL	\$ 23,911.43
		LABOR	\$ 17,914.71
	1600A SWBD PRICE	MATERIAL	\$ 4,275.00
		LABOR	\$ 1,200.00
	TOTAL:		\$ 71,162.87

SAVINGS: **\$ 205,540.83**

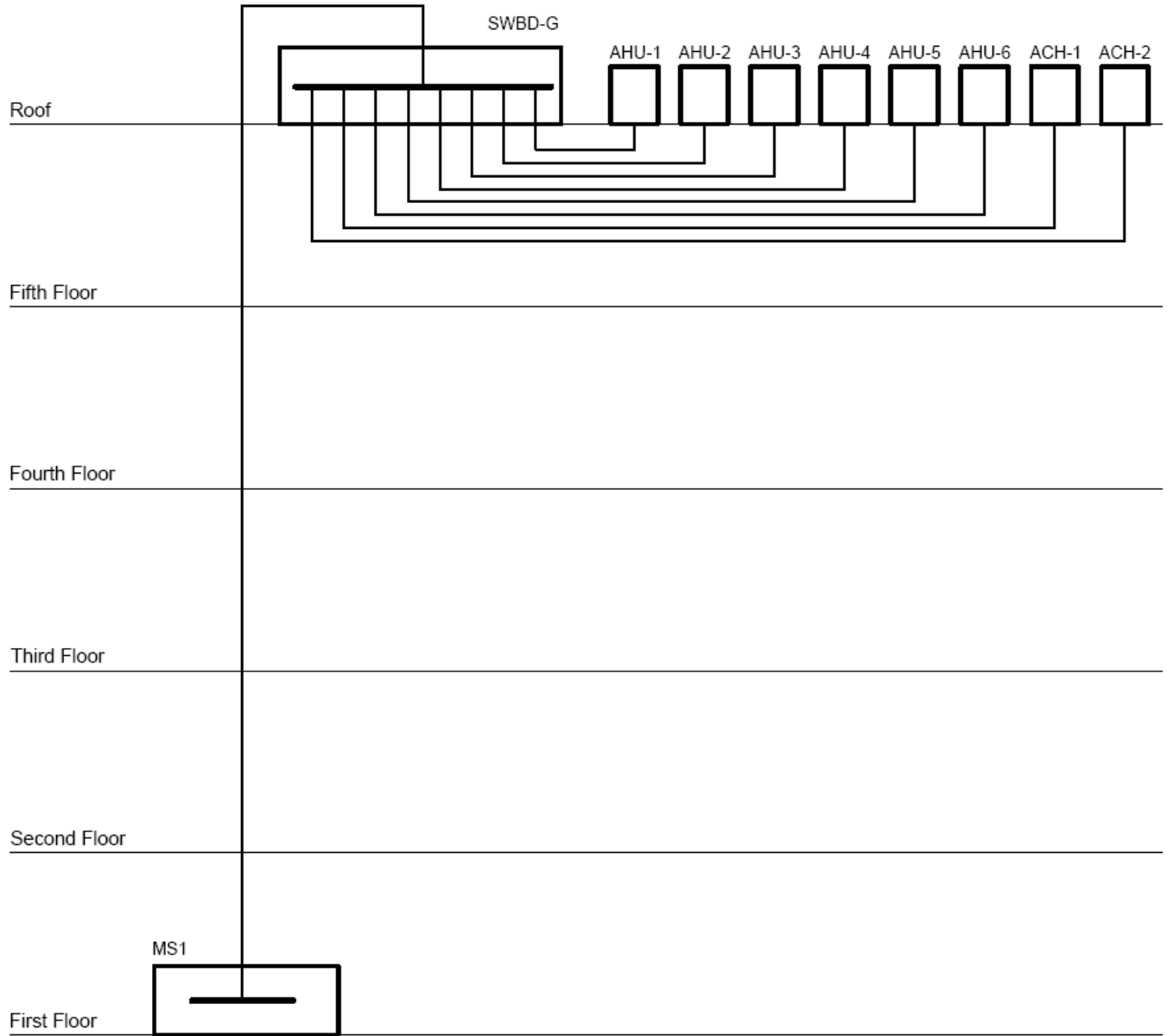
The total cost savings can be calculated using the following formula:

$$\text{Total Savings (\$)} = (\text{Total Cost of Existing system}) - (\text{Total cost of Proposed System}) .$$

$$\text{Total Savings (\$)} = \$276,703.70 - \$71,162.87$$

$$\text{Total Savings (\$)} = \$205,540.83$$

Because it has been determined during the cost calculations that a rooftop transformer is not practical from a cost standpoint, an updated schematic diagram of the proposed system is needed. The figure below shows the updated schematic riser diagram with the rooftop transformer eliminated.



4 | depth topic 2 | SKM Study

Introduction

This section is dedicated to presenting the results an purpose of the electrical depth topic 2. For electrical depth 2, a short circuit and arc flash analysis was performed on the existing electrical system. Both of these calculations were performed in the software program SKM.

Short Circuit Analysis

A short circuit is a condition that occurs when a connection experiences zero voltage between two nodes that would, under normal conditions, be at different voltages. As per the equation, $I = \frac{V}{R}$, as the resistance approaches zero, the current approaches infinity. The resulting (excessive) electrical current is limited only by the circuits' thévenin equivalent resistance. These high currents can cause overheating, damage to the wire insulation and fire, explosion, and damage to the circuit. The table that follows shows the calculated available short circuit current at each panelboard in the electrical distribution system.

The following table, created from data extracted from the program SKM, shows the available short-circuit current as well as the actual AIC rating (taken from the drawings). The last column, labeled "OK?", compares the actual rating against the SKM available short-circuit current. If the actual rating is higher than the SKM value, the result is "Yes," which says the criteria has been met; if not, the result is "No," meaning the actual AIC rating is too low.

BUS NAME	VOLTAGE (L-L)	AVAILABLE FAULT CURRENT				AIC RATING		
		THREE PHASE	X/R	LINE/GRD	X/R	SKM	ACTUAL	OK?
1AP-MER	208	2224.4	0.1	0.1	1	2224.4	22000	Yes
1DP-MER	208	35794.1	1.1	0.1	1	35794.1	22000	No
1EDP-EQ	208	10851.5	1.1	0.1	1	10851.5	42000	Yes
1EDP-LS	208	22443.6	1.3	0.1	1	22443.6	42000	Yes
2AP-A	208	21370.2	0.4	0.1	1	21370.2	22000	Yes
2AP-B	208	23820.4	0.6	0.1	1	23820.4	22000	No
3LP-A	208	20909.5	0.4	0.1	1	20909.5	22000	Yes
3LP-DIM-1	208	23820.4	0.6	0.1	1	23820.4	22000	No
3LP-DIM-2	208	13429	0.3	0.1	1	13429	22000	Yes
4AP-B	208	23820.4	0.6	0.1	1	23820.4	22000	No
5AP-A	208	14694	0.7	0.1	1	14694	22000	Yes
5AP-A1	208	8475	0.5	0.1	1	8475	22000	Yes
5AP-A2	208	8475	0.5	0.1	1	8475	22000	Yes
5AP-A3	208	8475	0.5	0.1	1	8475	22000	Yes
5AP-K1	208	4786	0.4	0.1	1	4786	22000	Yes
5AP-K2	208	3364.9	0.3	0.1	1	3364.9	22000	Yes
5AP-K3	208	1413.2	0.1	0.1	1	1413.2	22000	Yes
5DP-K1	208	22443.6	1.3	0.1	1	22443.6	22000	No
5LP-A	208	21370.2	0.4	0.1	1	21370.2	22000	Yes
MCC-MER	208	13741.8	1.1	0.1	1	13741.8	65000	Yes
MS1	208	181105.1	1	0.1	1	181105.1	200000	Yes
MS1_Service	208	200000	1	0.1	1	200000	200000	Yes
MS2	208	167867.7	1	0.1	1	167867.7	200000	Yes
RAP-MER	208	7466	0.8	0.1	1	7466	42000	Yes
SUP-RAP	208	6835.9	0.8	0.1	1	6835.9	22000	Yes
SWBD-EM	208	7497.2	8.5	7185.7	7.9	7497.2	65000	Yes
SWBD-G	208	8214.1	20	8214.1	20	8214.1	100000	Yes

Arc Flash Analysis

An arc flash is an electrical explosion that has sufficient electrical energy to cause, injury, fire, or substantial damage. These are the result of a low impedance connection to ground or phase in the electrical system. SKM, the software used to conduct the analysis, performs its calculation based on the following steps:

1. Range of the model
2. Apply 3 Phase Fault to each bus in the power system, calculate the Bolted Fault Current at the bus (IB) and the Bolted Fault Current through each protective device (IB br).
3. Calculate the Arcing Fault Current at the bus (Ia) and through each protective device (Ia br).
 - $I_g(Ia) = K + 0.662 I_g(IB) + 0.0966 V + 0.000526 G + 0.5588 V I_g(IB) - 0.00304 G I_g(IB)$
 - Variables defined as following:

Ig	log10
Ia	arcing fault current at the bus
K	-0.153 for open configuration and -0.097 for box configuratio
IB	bolted fault current – 3phase sym rms kA at the bus
V	bus voltage in kV
G	bus bar gap between conductors in mm

4. Determine the Trip/Delay time for fuses from the Time Current Coordination Curve (TCC).
 - Conditions as defined as following:

Trip/Delay Time	Condition
Read from clearing curve	$I_a < I_L$
1/2 cycles	$I_L \geq I_a \geq 2 I_L$
1/4 cycles	$I_a > 2 I_L$

5. Determine the Arcing duration by adding the Trip/Delay time and Breaker Opening time
6. Determine the Equipment Type:

Equipment Type	kV
Panel	≤ 1
Switchgear	≤ 35
Air	> 35

7. Determine the bus bar gap

Classes of Equipment	Gap (mm)
≤ 1 kV Switchgear	32
≤ 1 kV MCCs and Panelboards	25
1 – 5 kV Switchgear	104
>5 kV Switchgear	152
All Cable	13
1 – 5 kV Open Air	104
> 5 kV Open Air	152

8. Determine the Working Distance (Default the working distance based on the voltage level and equipment type.

Working Distance	Equipment Type	kV
24 inches (610mm)	Switchgear	<= 1
18 inches (455mm)	Panel	< =1
36 inches (910mm)	Switchgear	> 1 & < 35
72 inches (1829mm)	Switchgear	> 35
18 inches (455mm)	all others	

9. Calculate the Incident Energy

- $lg (En) = K1 + K2 + 1.081 lg (Ia) + 0.0011 G$

En	is incident energy (J/cm ²) normalized for a arcing duration of 0.2s and working distance of 610mm
K1	is -0.792 for open configuration and is -0.555 for box configuration (switchgear, panel, cable)
K2	is 0 for ungrounded and high resistance grounded systems and is -0.113 for grounded systems
G	is the gap between bus bar conductors in mm

10. Calculate the Arc Flash Boundary DB

- $DB = [4.184 Cf En (t/0.2) (610^X / EB)] ^ 1/X$

DB	is the arc flash boundary in mm at incident energy of EB
EB	is the limit for a second-degree bare skin burn. EB = 5.0 (J/cm ²)

11. Determine the PPE Clothing Category by a simple table look-up from the PPE table Personnel Protection Equipment Table.
12. Determine the Glove Class based on the voltage level. The following Glove Class table comes from ASTM D 120-95.

Glove Class	Voltage
00	500 V
0	1000 V
1	7500 V
2	17,000 V
3	26,500 V
4	36,000 V

Panel Number	Bus Name	Protective Device Name	Bus kV	Bus Bolted Fault (kA)	Bus Arcing Fault (kA)	Prot Dev Bolted Fault (kA)
1	1AP-MER	BKR_1AP-MER	0.208	2.22	1.51	2.22
2	1DP-MER	BKR_1DP-MER	0.208	35.79	10.65	35.79
3	1EDP-EQ	FUSE_MS1	0.208	10.85	4.61	10.85
4	1EDP-LS	FUSE_ATS-LS	0.208	22.44	7.67	22.44
5	2AP-A	BKR_2AP-A	0.208	21.37	6.3	21.37
6	2AP-B	BKR_2AP-B	0.208	23.82	8	23.82
7	3LP-A	BKR_3LP-A	0.208	20.91	7.3	20.91
8	3LP-DIM-1	FUSE_3LP-DIM-1	0.208	23.82	8	23.82
9	3LP-DIM-2	FUSE_3LP-DIM-2	0.208	13.43	4.55	13.43
10	4AP-B	BKR_4AP-B	0.208	23.82	6.8	23.82
11	5AP-A	BKR_5AP-A	0.208	14.69	4.84	14.69
12	5AP-A1	BKR_5AP-A	0.208	8.47	3.87	8.47
13	5AP-A2	BKR_5AP-A	0.208	8.47	3.87	8.47
14	5AP-A3	BKR_5AP-A	0.208	8.47	3.87	8.47
15	5AP-K1	BKR_5AP-K 1	0.208	4.79	2.59	4.79
16	5AP-K2	BKR_5AP-K 2	0.208	3.36	2.02	3.36
17	5AP-K3	BKR_5AP-K 3	0.208	1.41	1.1	1.41
18	5DP-K1	FUSE_5DP-K1	0.208	22.44	7.67	22.44
19	5LP-A	BKR_5LP-A	0.208	21.37	7.41	21.37
20	MCC-MER	FUSE_MCC-MER	0.208	13.74	5.44	13.74
21	MS1	FUSE_MS1	0.208	181.11	181.11	181.11
22	MS1_Service	MaxTripTime @2.0s	0.208	200	200	200
23	MS2	FUSE_MS2	0.208	167.87	167.87	167.87
24	RAP-MER	BKR_RAP-MER	0.208	7.47	3.54	7.47
25	SUP-RAP	BKR_SUP-RAP	0.208	6.84	3.33	6.84
26	SWBD-EM	BKR_SWBD-EM	0.208	7.5	3.02	7.5
27	SWBD-G	MaxTripTime @2.0s	0.208	8.21	3.79	8.21

Panel Number	Bus Name	Protective Device Name	Bus kV	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time (sec.)
1	1AP-MER	BKR_1AP-MER	0.208	1.51	0.065	0
2	1DP-MER	BKR_1DP-MER	0.208	10.65	0.01	0
3	1EDP-EQ	FUSE_MS1	0.208	4.61	2	0
4	1EDP-LS	FUSE_ATS-LS	0.208	7.67	2	0
5	2AP-A	BKR_2AP-A	0.208	6.3	0.032	0
6	2AP-B	BKR_2AP-B	0.208	8	0.01	0
7	3LP-A	BKR_3LP-A	0.208	7.3	0.01	0
8	3LP-DIM-1	FUSE_3LP-DIM-1	0.208	8	0.01	0
9	3LP-DIM-2	FUSE_3LP-DIM-2	0.208	4.55	0.1	0
10	4AP-B	BKR_4AP-B	0.208	6.8	0.032	0
11	5AP-A	BKR_5AP-A	0.208	4.84	0.024	0
12	5AP-A1	BKR_5AP-A	0.208	3.87	0.09	0
13	5AP-A2	BKR_5AP-A	0.208	3.87	0.09	0
14	5AP-A3	BKR_5AP-A	0.208	3.87	0.09	0
15	5AP-K1	BKR_5AP-K 1	0.208	2.59	0.1	0
16	5AP-K2	BKR_5AP-K 2	0.208	2.02	0.1	0
17	5AP-K3	BKR_5AP-K 3	0.208	1.1	0.1	0
18	5DP-K1	FUSE_5DP-K1	0.208	7.67	0.1	0
19	5LP-A	BKR_5LP-A	0.208	7.41	0.01	0
20	MCC-MER	FUSE_MCC-MER	0.208	5.44	2	0
21	MS1	FUSE_MS1	0.208	181.11	0.008	0
22	MS1_Service	MaxTripTime @2.0s	0.208	200	2	0
23	MS2	FUSE_MS2	0.208	167.87	0.004	0
24	RAP-MER	BKR_RAP-MER	0.208	3.54	0.09	0
25	SUP-RAP	BKR_SUP-RAP	0.208	3.33	0.1	0
26	SWBD-EM	BKR_SWBD-EM	0.208	3.02	0.309	0
27	SWBD-G	MaxTripTime @2.0s	0.208	3.79	2	0

Panel Number	Bus Name	Protective Device Name	Bus kV	Ground	Equip Type	Gap (mm)
1	1AP-MER	BKR_1AP-MER	0.208	No	PNL	25
2	1DP-MER	BKR_1DP-MER	0.208	No	PNL	25
3	1EDP-EQ	FUSE_MS1	0.208	No	PNL	25
4	1EDP-LS	FUSE_ATS-LS	0.208	No	PNL	25
5	2AP-A	BKR_2AP-A	0.208	No	PNL	25
6	2AP-B	BKR_2AP-B	0.208	No	PNL	25
7	3LP-A	BKR_3LP-A	0.208	No	PNL	25
8	3LP-DIM-1	FUSE_3LP-DIM-1	0.208	No	PNL	25
9	3LP-DIM-2	FUSE_3LP-DIM-2	0.208	No	PNL	25
10	4AP-B	BKR_4AP-B	0.208	No	PNL	25
11	5AP-A	BKR_5AP-A	0.208	No	PNL	25
12	5AP-A1	BKR_5AP-A	0.208	No	PNL	25
13	5AP-A2	BKR_5AP-A	0.208	No	PNL	25
14	5AP-A3	BKR_5AP-A	0.208	No	PNL	25
15	5AP-K1	BKR_5AP-K 1	0.208	No	PNL	25
16	5AP-K2	BKR_5AP-K 2	0.208	No	PNL	25
17	5AP-K3	BKR_5AP-K 3	0.208	No	PNL	25
18	5DP-K1	FUSE_5DP-K1	0.208	No	PNL	25
19	5LP-A	BKR_5LP-A	0.208	No	PNL	25
20	MCC-MER	FUSE_MCC-MER	0.208	No	PNL	25
21	MS1	FUSE_MS1	0.208	No	PNL	25
22	MS1_Service	MaxTripTime @2.0s	0.208	No	PNL	25
23	MS2	FUSE_MS2	0.208	No	PNL	25
24	RAP-MER	BKR_RAP-MER	0.208	No	PNL	25
25	SUP-RAP	BKR_SUP-RAP	0.208	No	PNL	25
26	SWBD-EM	BKR_SWBD-EM	0.208	Yes	PNL	25
27	SWBD-G	MaxTripTime @2.0s	0.208	Yes	PNL	25

Panel Number	Bus Name	Protective Device Name	Bus kV	Arc Flash Boundary (in)	Working Distance (in)	Incident Energy (cal/cm ²)
1	1AP-MER	BKR_1AP-MER	0.208	9	18	0.36
2	1DP-MER	BKR_1DP-MER	0.208	10	18	0.46
3	1EDP-EQ	FUSE_MS1	0.208	146	18	37
4	1EDP-LS	FUSE_ATS-LS	0.208	205	18	65
5	2AP-A	BKR_2AP-A	0.208	14	18	0.84
6	2AP-B	BKR_2AP-B	0.208	8	18	0.34
7	3LP-A	BKR_3LP-A	0.208	8	18	0.31
8	3LP-DIM-1	FUSE_3LP-DIM-1	0.208	8	18	0.34
9	3LP-DIM-2	FUSE_3LP-DIM-2	0.208	23	18	1.8
10	4AP-B	BKR_4AP-B	0.208	15	18	0.91
11	5AP-A	BKR_5AP-A	0.208	10	18	0.47
12	5AP-A1	BKR_5AP-A	0.208	20	18	1.4
13	5AP-A2	BKR_5AP-A	0.208	20	18	1.4
14	5AP-A3	BKR_5AP-A	0.208	20	18	1.4
15	5AP-K1	BKR_5AP-K 1	0.208	16	18	1
16	5AP-K2	BKR_5AP-K 2	0.208	14	18	0.77
17	5AP-K3	BKR_5AP-K 3	0.208	9	18	0.4
18	5DP-K1	FUSE_5DP-K1	0.208	33	18	3.2
19	5LP-A	BKR_5LP-A	0.208	8	18	0.31
20	MCC-MER	FUSE_MCC-MER	0.208	163	18	45
21	MS1	FUSE_MS1	0.208	14	18	0.77
22	MS1_Service	MaxTripTime @2.0s	0.208	235	18	204
23	MS2	FUSE_MS2	0.208	10	18	0.36
24	RAP-MER	BKR_RAP-MER	0.208	19	18	1.3
25	SUP-RAP	BKR_SUP-RAP	0.208	19	18	1.3
26	SWBD-EM	BKR_SWBD-EM	0.208	30	18	2.8
27	SWBD-G	MaxTripTime @2.0s	0.208	110	18	23

Panel Number	Bus Name	Protective Device Name	Bus kV	Required Protective FR Clothing Category	Label #
1	1AP-MER	BKR_1AP-MER	0.208	Category 0	# 0001
2	1DP-MER	BKR_1DP-MER	0.208	Category 0	# 0002
3	1EDP-EQ	FUSE_MS1	0.208	Category 4 (*N9)	# 0003
4	1EDP-LS	FUSE_ATS-LS	0.208	Dangerous! (*N9)	# 0004
5	2AP-A	BKR_2AP-A	0.208	Category 0 (*N3)	# 0005
6	2AP-B	BKR_2AP-B	0.208	Category 0	# 0006
7	3LP-A	BKR_3LP-A	0.208	Category 0	# 0007
8	3LP-DIM-1	FUSE_3LP-DIM-1	0.208	Category 0	# 0008
9	3LP-DIM-2	FUSE_3LP-DIM-2	0.208	Category 1 (*N3)	# 0009
10	4AP-B	BKR_4AP-B	0.208	Category 0 (*N3)	# 0010
11	5AP-A	BKR_5AP-A	0.208	Category 0 (*N3)	# 0011
12	5AP-A1	BKR_5AP-A	0.208	Category 1	# 0012
13	5AP-A2	BKR_5AP-A	0.208	Category 1	# 0013
14	5AP-A3	BKR_5AP-A	0.208	Category 1	# 0014
15	5AP-K1	BKR_5AP-K 1	0.208	Category 0	# 0015
16	5AP-K2	BKR_5AP-K 2	0.208	Category 0	# 0016
17	5AP-K3	BKR_5AP-K 3	0.208	Category 0	# 0017
18	5DP-K1	FUSE_5DP-K1	0.208	Category 1	# 0018
19	5LP-A	BKR_5LP-A	0.208	Category 0	# 0019
20	MCC-MER	FUSE_MCC-MER	0.208	Dangerous! (*N9)	# 0020
21	MS1	FUSE_MS1	0.208	Category 0 (*N11)	# 0021
22	MS1_Service	MaxTripTime @2.0s	0.208	Dangerous!	# 0022
23	MS2	FUSE_MS2	0.208	Category 0 (*N11)	# 0023
24	RAP-MER	BKR_RAP-MER	0.208	Category 1	# 0024
25	SUP-RAP	BKR_SUP-R AP	0.208	Category 1	# 0025
26	SWBD-EM	BKR_SWBD-EM	0.208	Category 1 (*N3)	# 0026
27	SWBD-G	MaxTripTime @2.0s	0.208	Category 3 (*N2) (*N9)	# 0027

Load Flow Analysis

BRANCH NAME	FROM NAME	TO NAME	TYPE	VD %	AMPS	KVA	RATING %
WIRE_MS1	MS1_Service	MS1	FDR	0	3667.61	1293.76	87.74
WIRE_MS2	MS1_Service	MS2	FDR	0.12	1620.52	571.64	71.08
WIRE_5DPK1	MS2	5DP-K1	FDR	0.48	206.64	72.8	54.38
WIRE_5APK1	5DP-K1	5AP-K1	FDR	1.71	101.62	35.63	88.36
WIRE_5APK2	5DP-K1	5AP-K2	FDR	2.36	90.62	31.77	106.61
WIRE_5APK3	5DP-K1	5AP-K3	FDR	0.97	14.41	5.05	28.81
CBL-0007	MS2	3LP-DIM-1	FDR	0.42	131.13	46.2	65.56
WIRE_2AP-B	MS2	2AP-B	FDR	0	0	0	0
WIRE_5AP-A1	5AP-A	5AP-A1	FDR	0.16	31.4	11.02	27.3
WIRE_5AP-A2	5AP-A	5AP-A2	FDR	0.1	19.97	7.01	17.36
WIRE_5AP-A3	5AP-A	5AP-A3	FDR	0.12	22.83	8.01	19.85
WIRE_5AP-A	MS2	5AP-A	FDR	0.39	74.19	26.14	32.26
WIRE_4AP-B	MS2	4AP-B	FDR	0.49	154.05	54.27	77.02
WIRE_2AP-A	MS2	2AP-A	FDR	0.66	165.75	58.4	127.5
WIRE_3LP-A	MS2	3LP-A	FDR	0.28	71.17	25.07	54.74
WIRE_5LP-A	MS2	5LP-A	FDR	0.23	56.9	20.05	43.77
WIRE_3LP-DIM-2	MS2	3LP-DIM-2	FDR	1.15	172.33	60.71	132.56
WIRE_1DP-MER	MS1	1DP-MER	FDR	0.51	332.06	117.14	107.12
WIRE_1AP-MER	1DP-MER	1AP-MER	FDR	2.49	58.49	20.52	89.98
WIRE_AHU-1	MS1	BUS-0031	FDR	1.32	284.71	100.43	74.92
WIRE_ACH-1/A	MS1	BUS-0033	FDR	2.14	608.62	214.69	80.08
WIRE_ACH-1/B	MS1	BUS-0035	FDR	2.25	638.31	225.16	83.99
WIRE_AHU-2	MS1	BUS-0037	FDR	1.32	284.71	100.43	74.92
WIRE_AHU-3	MS1	BUS-0039	FDR	1.62	219.13	77.3	57.67
WIRE_AHU-4	MS1	BUS-0040	FDR	2.35	499.56	176.22	131.46
WIRE_AHU_5	MS1	BUS-0041	FDR	2.35	499.56	176.22	131.46
WIRE_AHU-6	MS1	BUS-0042	FDR	1.59	340.02	119.94	89.48
WIRE_MCC-MER	MS1	MCC-MER	FDR	0	0	0	0
WIRE_RAP-MER	MCC-MER	RAP-MER	FDR	0	0	0	0
WIRE_SUP-RAP	RAP-MER	SUP-RAP	FDR	0	0	0	0
WIRE_SWBD-EM	SWBD-G	SWBD-EM	FDR	0	0	0	0
WIRE_LOADBANK	SWBD-G	BUS-0048	FDR	1.3	566.39	202.66	169.07
ATS-EQ	BUS-0054	BUS-0049	FDR	0	0	0	UNKOWN
WIRE_ATS-EQ2	MS1	BUS-0049	FDR	0	0	0	0
WIRE_1EDP-EQ	BUS-0055	1EDP-EQ	FDR	0	0	0	0
WIRE_ATS-EQ	BUS-0054	SWBD-EM	FDR	0	0	0	0
ATS-LS	BUS-0059	BUS-0058	FDR	0	672.83	234.02	UNKOWN
WIRE_1EDP-LS	BUS-0057	1EDP-LS	FDR	1.25	672.83	234.02	88.53
WIRE_ATS-LS	MS2	BUS-0058	FDR	1.25	672.83	237.04	88.53
WIRE_ATS-LS1	SWBD-EM	BUS-0059	FDR	0	0	0	0

Conclusion

The available short circuit current for the panelboards, as expected, decreases as you go further downstream of the service entrance (as well as downstream of the generator). The main discrepancy that arises with my SKM short-circuit calculation is that the available short circuit current at the different panelboards changes drastically with the input for service entrance current. Not knowing what to input, I decided to make the available short circuit current from the utility 200,000 amps. This decision was made because my two main service entrance switchboards, MS1 and MS2, are both rated as 200kAIC. That is, if we make the available utility current 200,000 amps, we can then compare whether or not the rest of the panelboards in the system have adequate AIC ratings as the main service switchboards approach inadequacy (i.e. what the available current would be above 200,000 amps).

Most of AIC rating of the panelboards proved to be sufficient enough in the event that a short-circuit current of 200,000 amps becomes available at the service entrance. Some panelboards, five of them to be exact, did not meet the requirement. The table below shows the SKM calculated available short-circuit current, as well as the actual AIC rating taken from the drawings. The actual value and SKM calculation are so close for panel's 2AP-B, 3LP-DIM-1, 4AP-B, and 5DP-K1, that it is hard to say with confidence that they aren't sufficient. This is because, especially since I am a beginner with the SKM software, that the small difference is due to a mistake in the model. Panel 1DP-MER, roughly 13,000 amps over the required value, would mostly likely be insufficient in the event that 200,000 amps of short-circuit current becomes available at the main distribution panel.

AIC RATING			
BUS NAME	SKM	ACTUAL	OK?
1DP-MER	35794.1	22000	No
2AP-B	23820.4	22000	No
3LP-DIM-1	23820.4	22000	No
4AP-B	23820.4	22000	No
5DP-K1	22443.6	22000	No

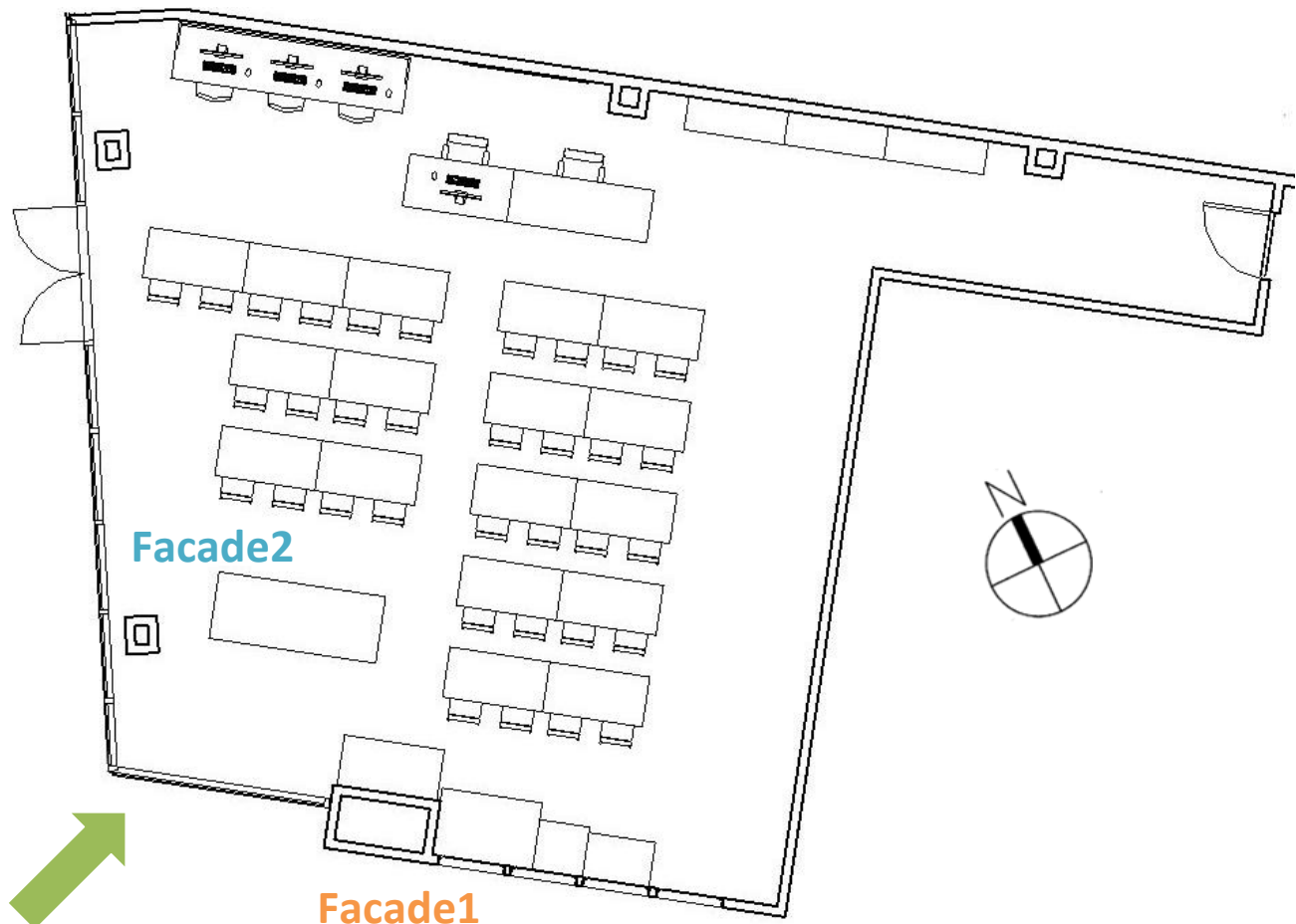
Breadth one (MAE): Daylighting

Introduction

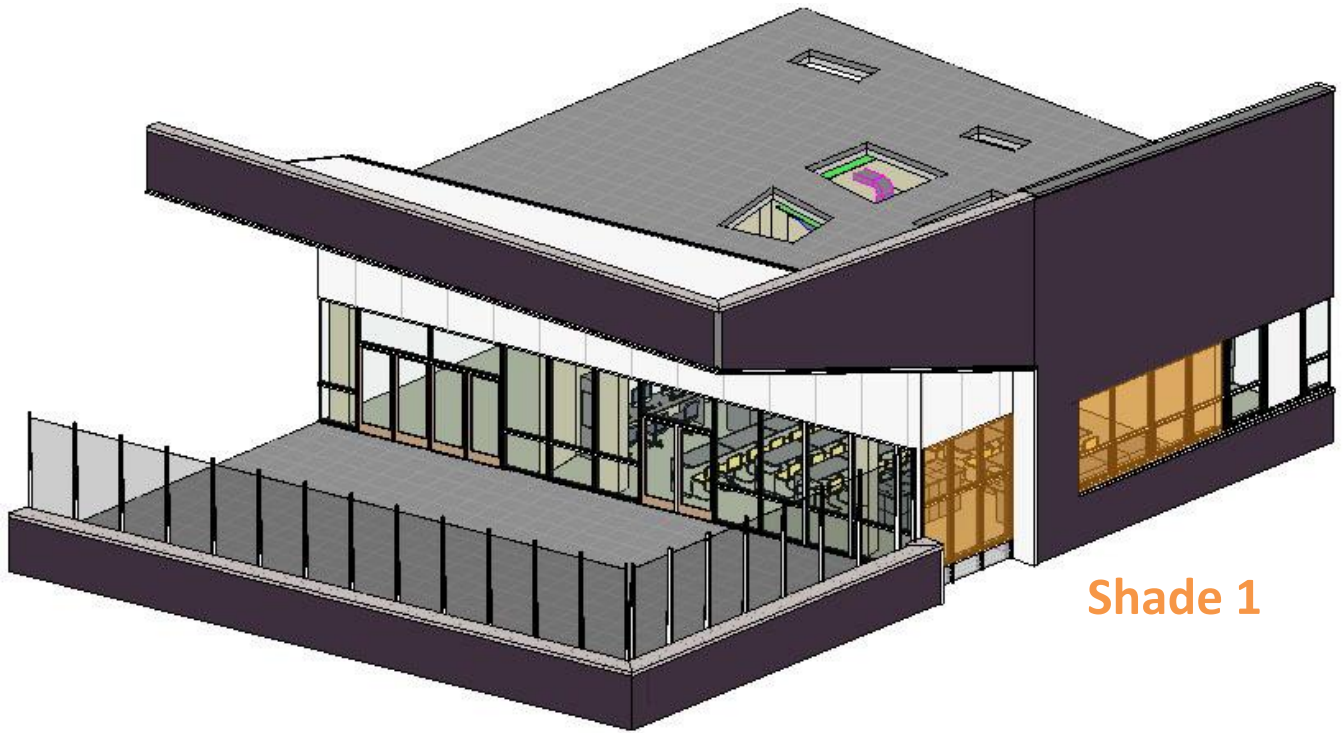
This section is dedicated to describing, in detail, the procedure and results for the MAE daylighting analysis. The High School Art Room, located on the south-west corner of fifth floor, was the basis for the analysis. For the existing space, no daylight penetration or shading devices were considered. As such, the goal of this breadth is to analyze the daylight distribution in the space, design a shading system to prevent direct sunlight penetration into the space, and implement a skylighting layout into the space that supplements the shading system. The steps to performing the MAE daylighting analysis, and the hierarchy of organization of this section of the report, are as follows:

- **Step 1:** Design shading system
- **Step 2:** Design skylight system to supplement shading system
- **Step 3:** Compare daylight distribution in space: shades only vs. skylights and shades
- **Step 4:** Analyze Cost Implications

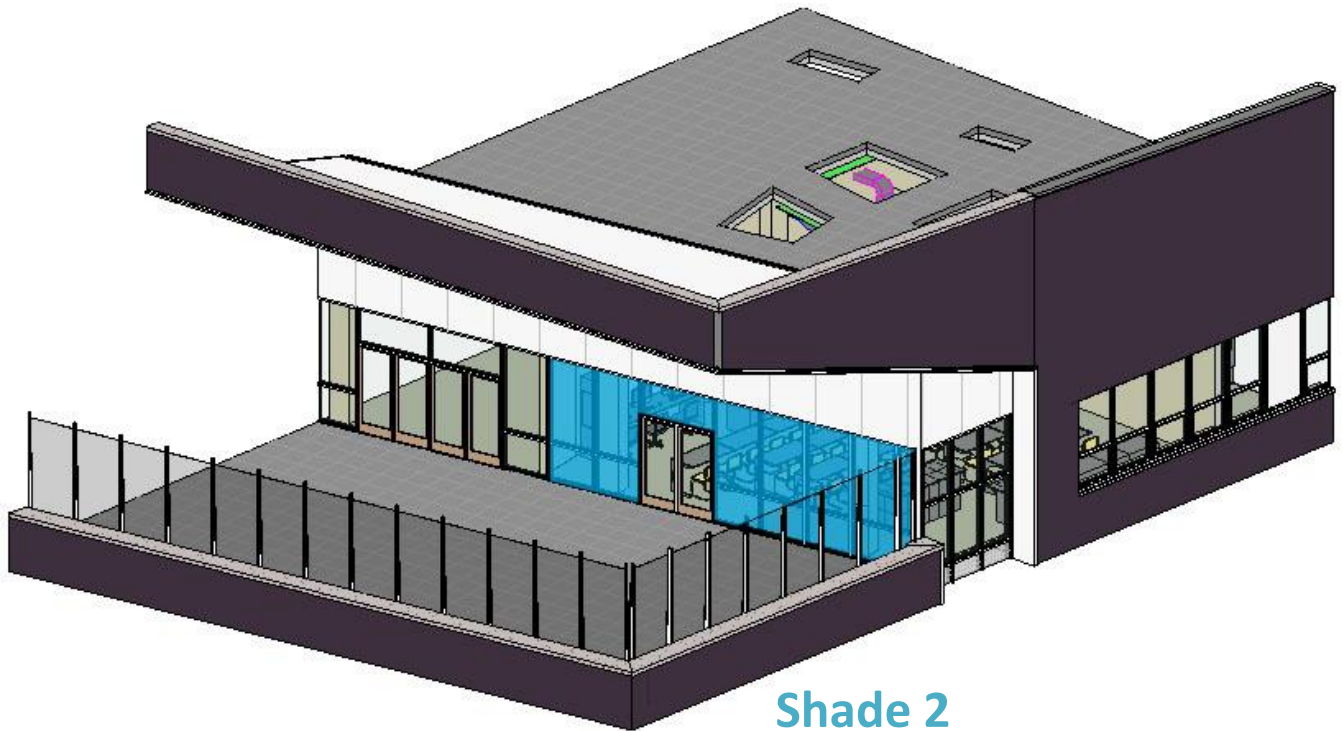
The layout of the space, as well as the two façades under consideration in this breadth analysis, are shown via the plan below. The plan south façade (**façade 1**) and the plan west façade (**façade 2**) are those for which shading devices will be designed. The **green** arrow indicates the elevation view for the figures on the next page.



The figures below show, in elevation, the location of **shade 1** and **shade 2**:



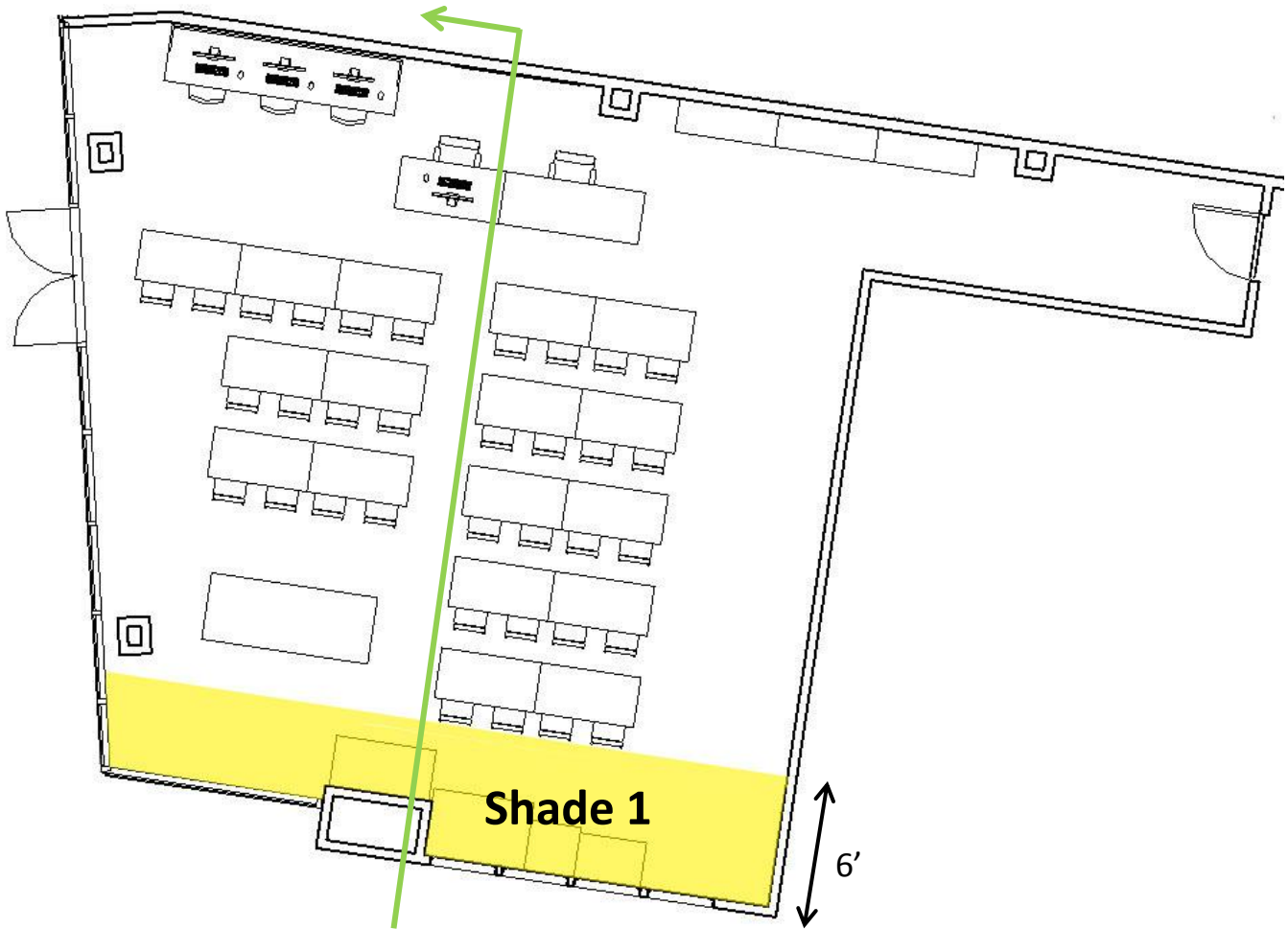
Shade 1



Shade 2

Step 1: Design shading system

The first step in designing an effective skylight and shading system is to determine the profile angle at which direct sun would penetrate the space on both façades. The figure below shows a plan of the High School Art Room indicating the location of *shade1* on the plan south façade. The green line and arrow through the plan indicates the section plane and viewing direction of the section on the next page.

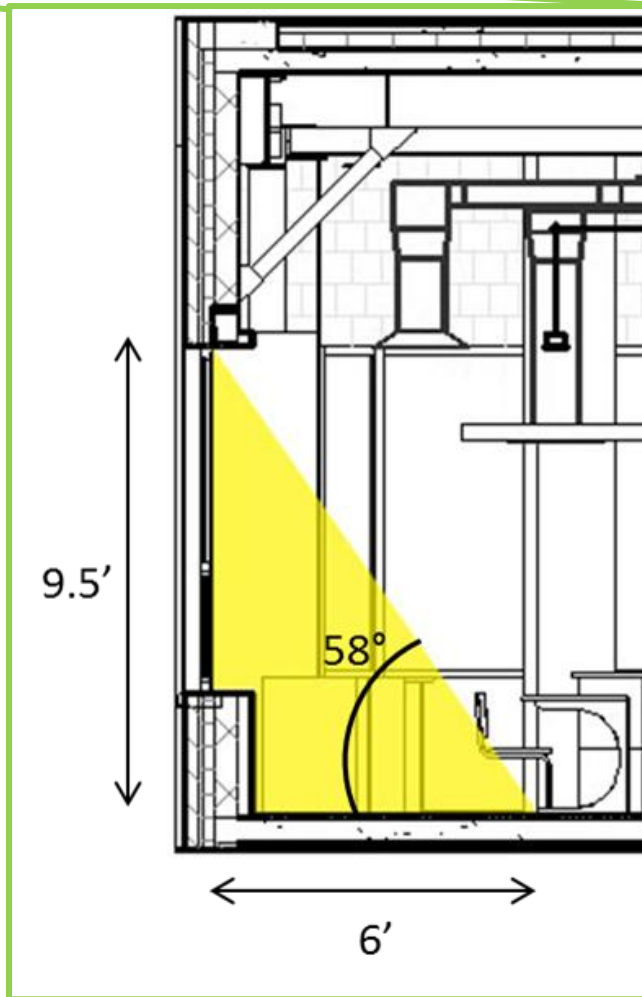
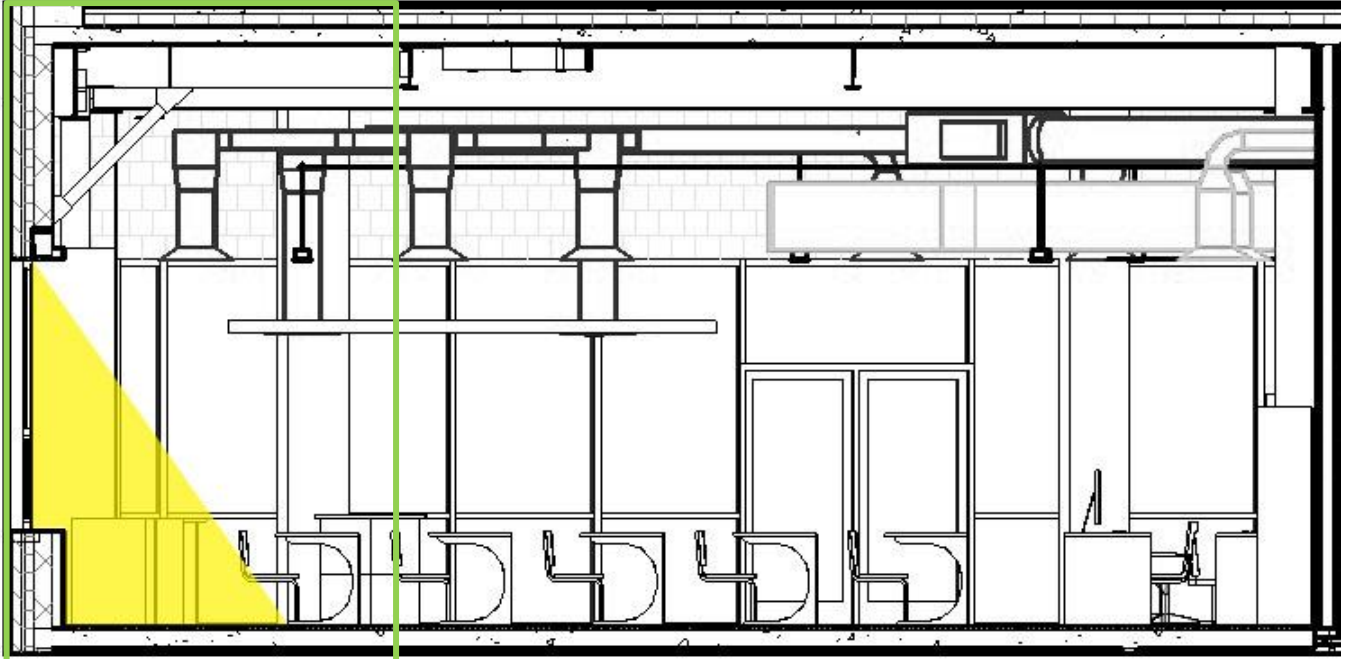


The section on the next page shows how the profile angle at which the shades come down was calculated. The rear desk in the space is located roughly 6 feet from the windows on *façade 1*. To prevent direct sunlight on those desks, we calculate the profile angle via the following equation:

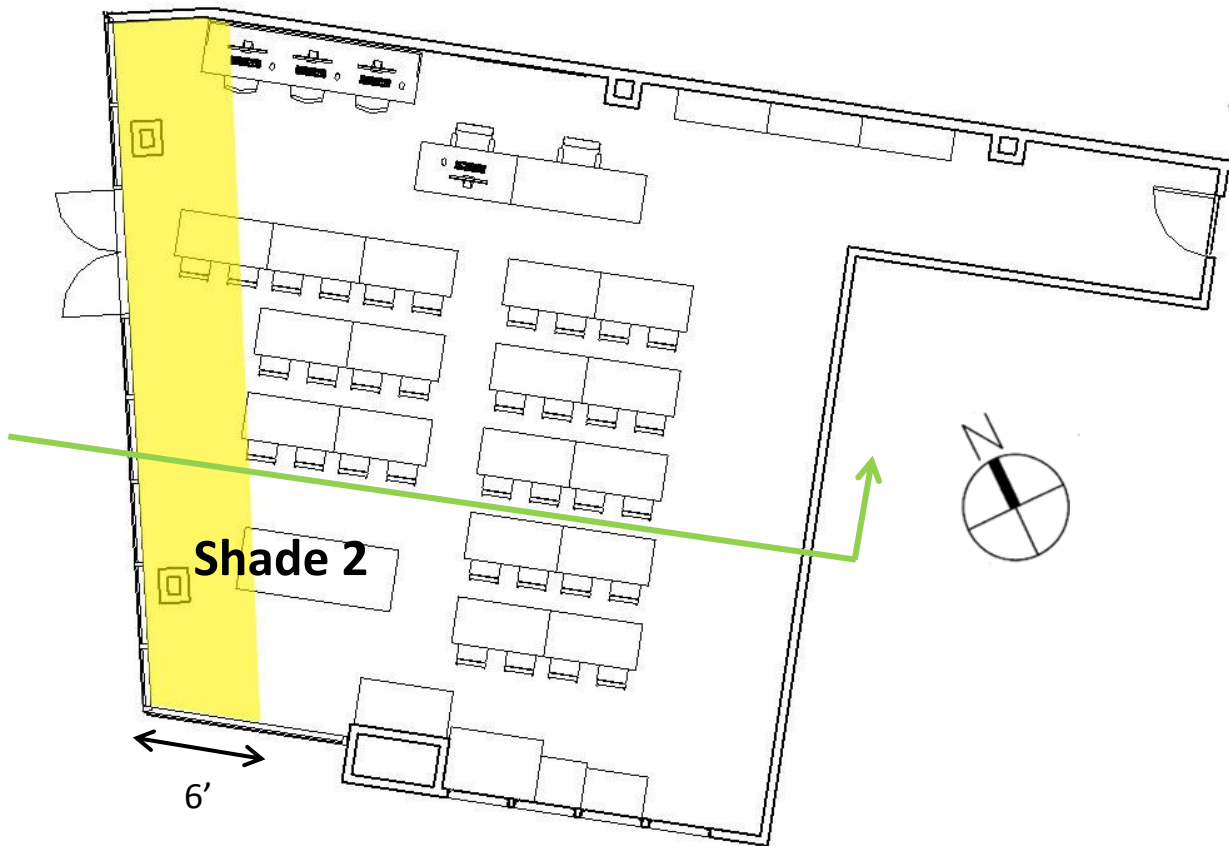
$$\tan(\theta_p) = \frac{(\text{Height of Window})}{(\text{Distance from window})}$$

$$(\theta_p)_1 = \tan^{-1}\left(\frac{\text{Height of Window}}{\text{Distance from window}}\right)$$

$$(\theta_p)_1 = \tan^{-1}\left(\frac{9.5'}{6'}\right) = \tan^{-1}(1.583) = 58^\circ$$



The figure below shows a plan of the High School Art Room indicating the location of *shade2* on the plan west façade. The **green** line and arrow through the plan indicate the section plane and viewing direction of the section on the next page.

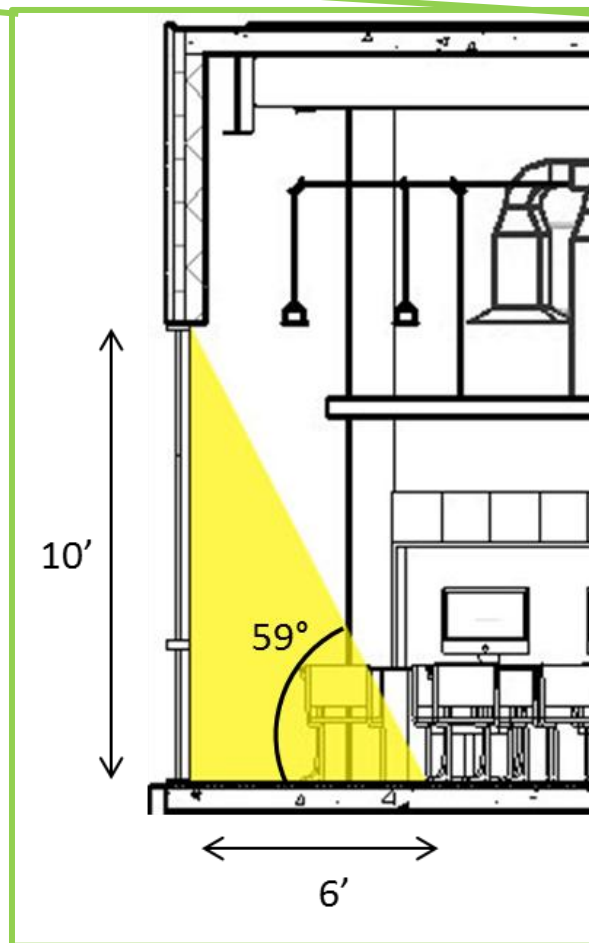
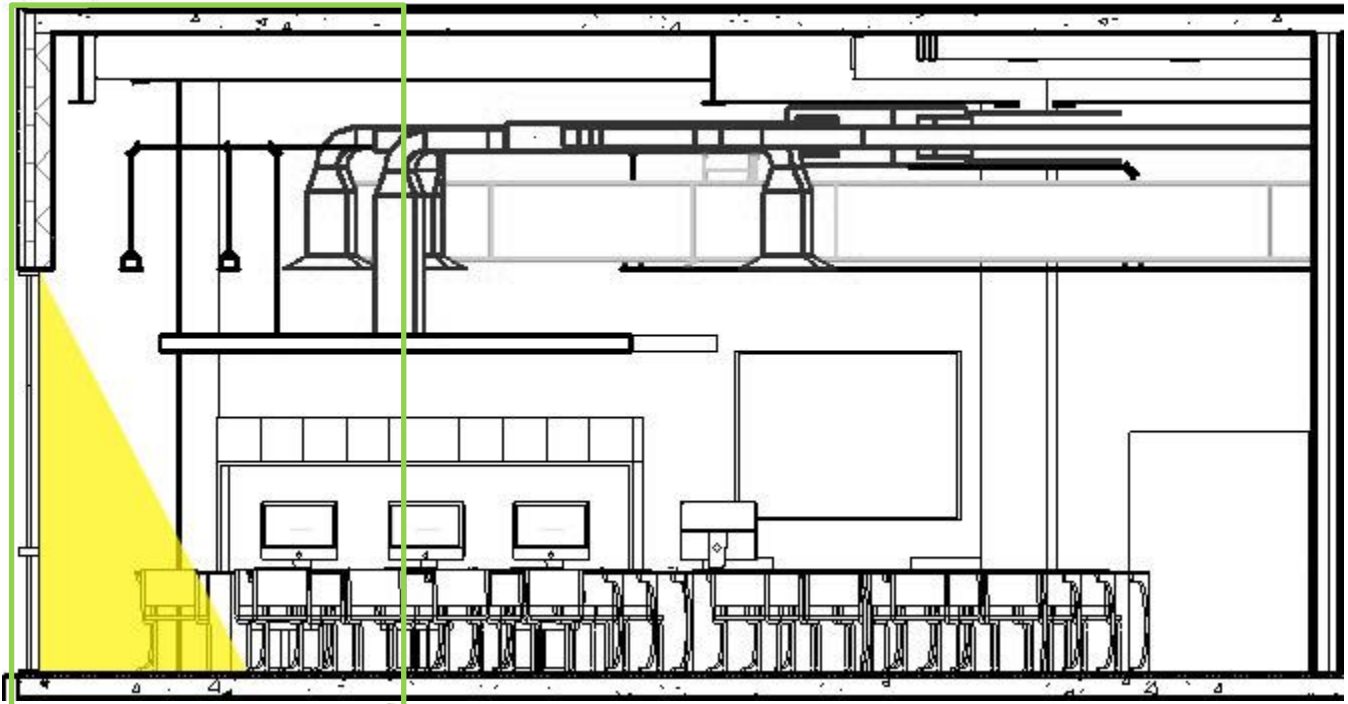


The section on the next page shows how the profile angle at which the shades come down was calculated. The rear desk in the space is located roughly 6 feet from the windows on *façade 2*. To prevent direct sunlight on those desks, we calculate the profile angle via the following equation:

$$\tan(\theta_p) = \frac{(\text{Height of Window})}{(\text{Distance from window})}$$

$$(\theta_p)_2 = \tan^{-1}\left(\frac{\text{Height of Window}}{\text{Distance from window}}\right)$$

$$(\theta_p)_2 = \tan^{-1}\left(\frac{10'}{6'}\right) = \tan^{-1}(1.583) = 59^\circ$$



Now that the profile angles for both facades are known, we need to determine how often the sun falls on each façade below the calculated profile angle. To summarize, the calculated profile angles for *façade 1* and *façade 2* are as follows:

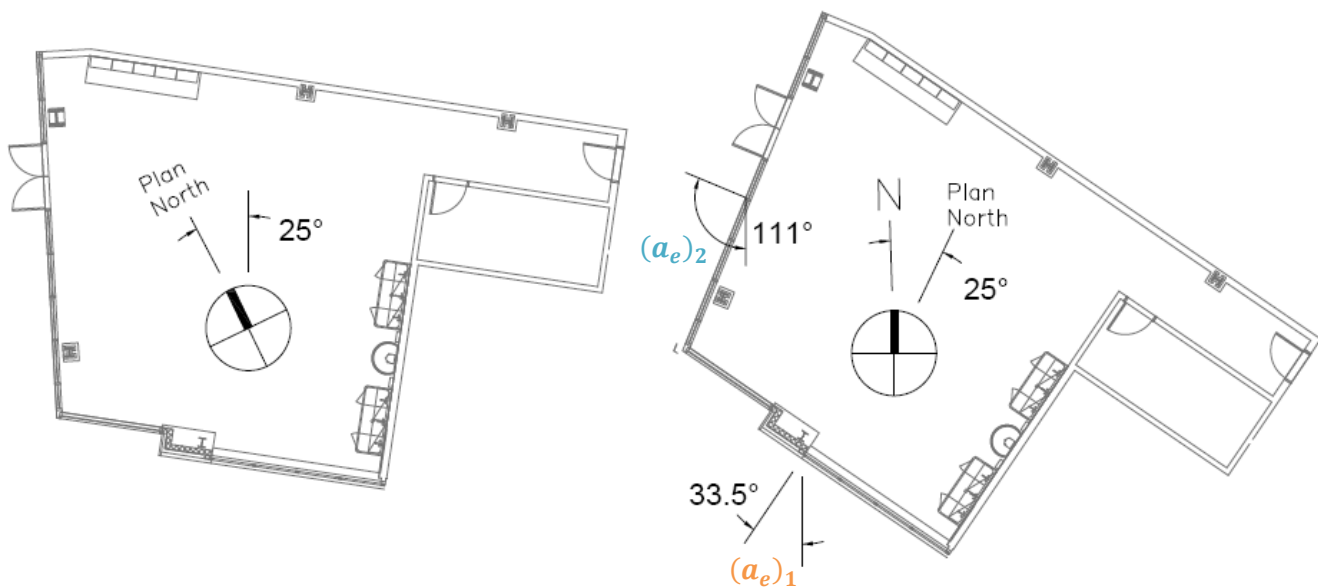
$$(\theta_p)_1 = 58^\circ$$

$$(\theta_p)_2 = 59^\circ$$

To determine how often the sun falls on the façade below the calculated profile angle, the elevation azimuth for each façade needs to be calculated. The plan on the left, in the figure below, represents how the space was presented on the drawings. Plan north is straight up (↑), with true north being represented by the dark bar on the compass (↖). Rotating the plan and the compass so that true north faces up (↑), we reveal the true orientation of the building. From the new plan, the elevation azimuth—which is the angle between south and the normal of the building face—can be calculated. The profile angles were calculated by hand, and verified in AutoCAD 2012. The profile angles calculated for *façade 1* and *façade 2* are as follows:

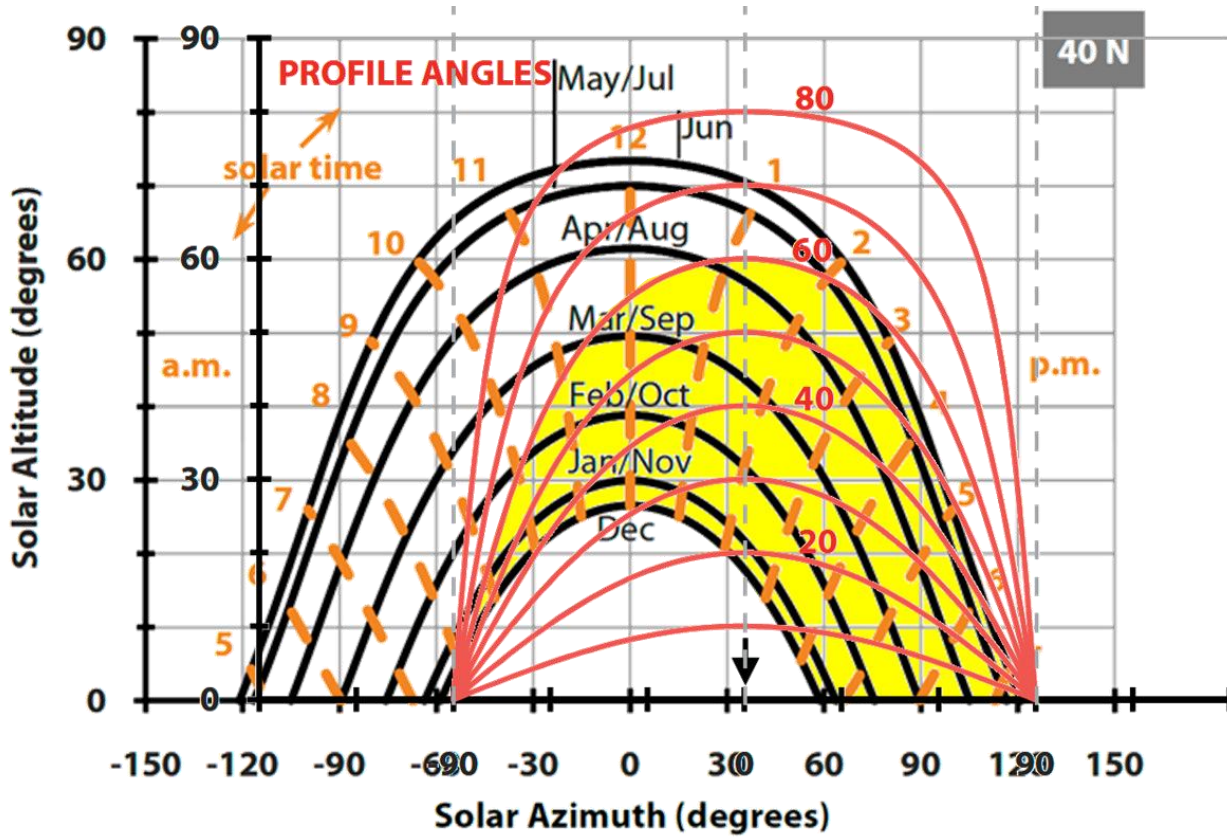
$$(a_e)_1 = 33.5^\circ$$

$$(a_e)_2 = 111^\circ$$

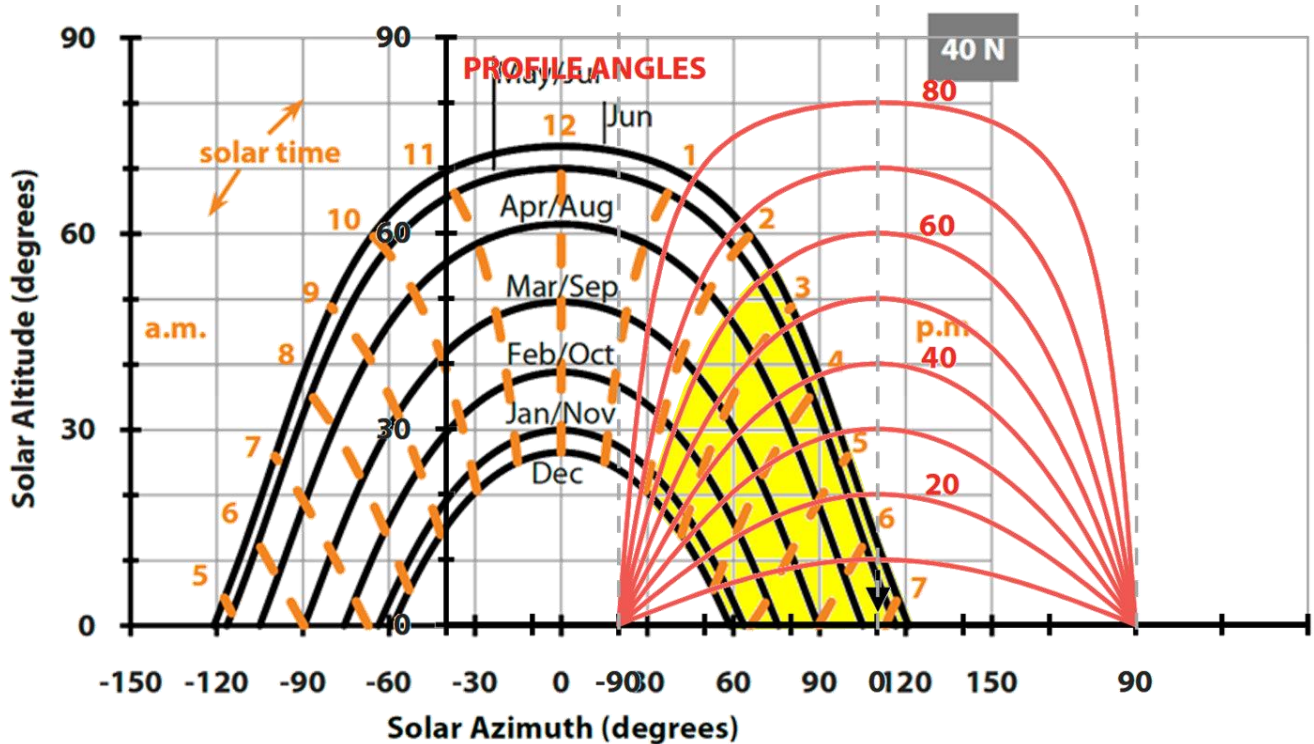


Now that the elevation azimuths for both facades are known, the duration of the year for which the sun falls on each façade below the calculated profile angle, can be shown. If we overlay the graph of solar profile angles (**Figure 14.41** from the 10th Edition IES Handbook) over top of the solar position graph for 40°N latitude (**Figure 7.8** from the 10th Edition IES Handbook), the overlap of the two graphs will show the total portion of the year which the sun falls on the façade below the profile angle. This overlap, for façade 1 and façade 2, are shown on the next page. The first figure, for *façade 1*, shows the variability across the year with which the sun falls on the façade under 58°. The second figure, for *façade 2*, shows that the sun falls below a profile angle of 59° all year round after 2pm.

Façade 1



Façade 2



The table below shows the numerical calculation of the total hours each shade comes down, which in turn, can be translated to the total number of occupancy hours the sun falls on each façade below the specified profile angle. This table is inclusive, meaning that, the calculated value for when shade 1 and shade 2 do not include overlap in shade conditions. For example column 5 gives the number of occupancy hours that shade 2 comes down; this number **includes** the hours that shade 2 is down that shade 1 is also down.

Percent (inclusive) Occupancy hours of shade conditions					
	Total Occupancy Hours	No shades down	shade1 down?	shade2 down?	Both Shades Down
Occupancy hours	2727	1185	1531	556	545
% of occupancy hours	100%	43.45%	56.14%	20.39%	19.99%

The table below is the exclusive version of the table previous. That is, each calculated shade condition **ONLY** includes the occupancy hours when that specific shade is down. For example, column 5 gives the number of occupancy hours that shade 2 comes down; this number **excludes** the occupancy hours that shade 2 is down that shade 1 is also down.

Percent (exclusive) Occupancy hours of shade conditions					
	Total Occupancy Hours	No shades down	shade1 down?	shade2 down?	Both Shades Down
Occupancy hours	2727	1185	986	11	545
% of occupancy hours	100%	43.45%	36.16%	0.40%	19.99%

Step 2: Design skylight system to supplement shading system

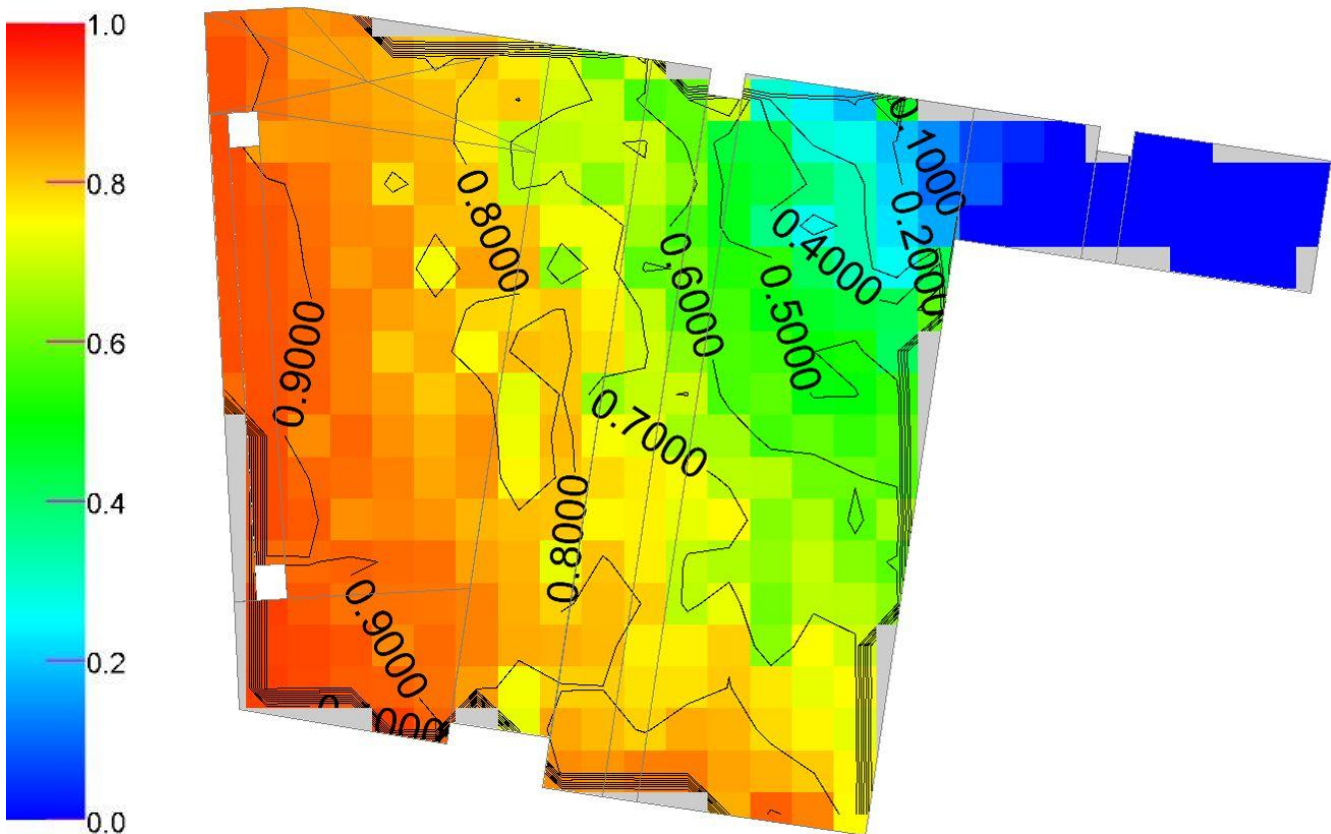
Once the profile angles are known, DAYSIM can be used to analyze the distribution of daylight in the space across the year. The goal, once the daylight distribution in the space under the shading condition is known, is to design a skylight layout that supplements the shading system. The figure below shows the daylight autonomy and spatial daylight autonomy for the High School Art Room with operable shades according to the profile angles calculated in the previous step. Utilizing operable shades, the space has a **Spatial Daylight Autonomy of 80.95** ($SDA_{250lux,50\%} = 80.95$). This means that 80.65% of the points in the room meet the target illuminance of 250 lux 50 percent of occupancy schedule.

Daylight Autonomy Cal

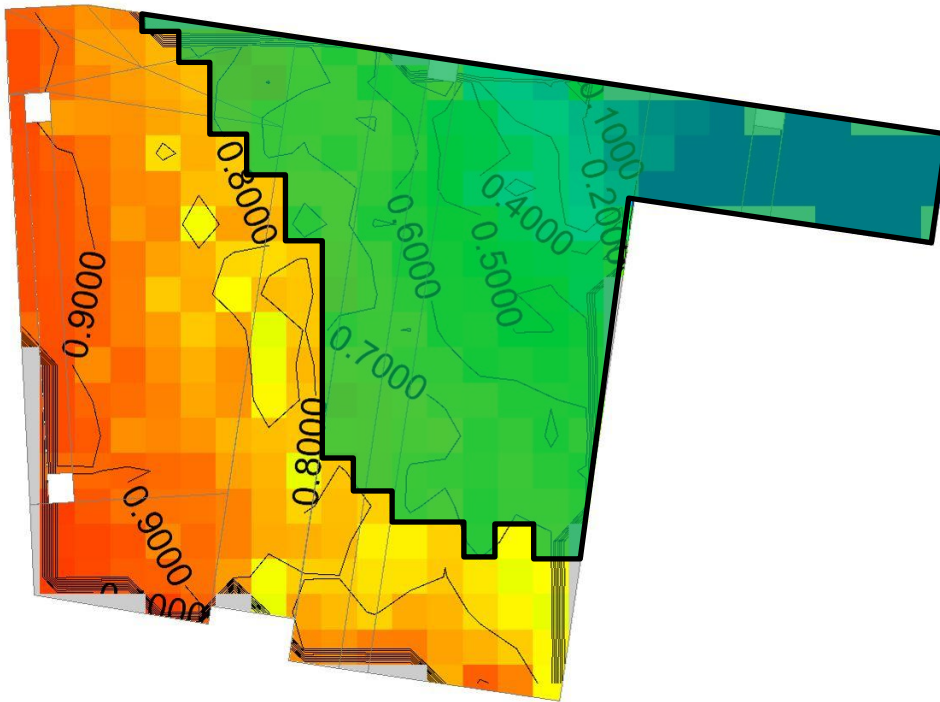
Percent of points above 50%: **80.95**

($SDA_{250lux,50\%} = 80.95$)

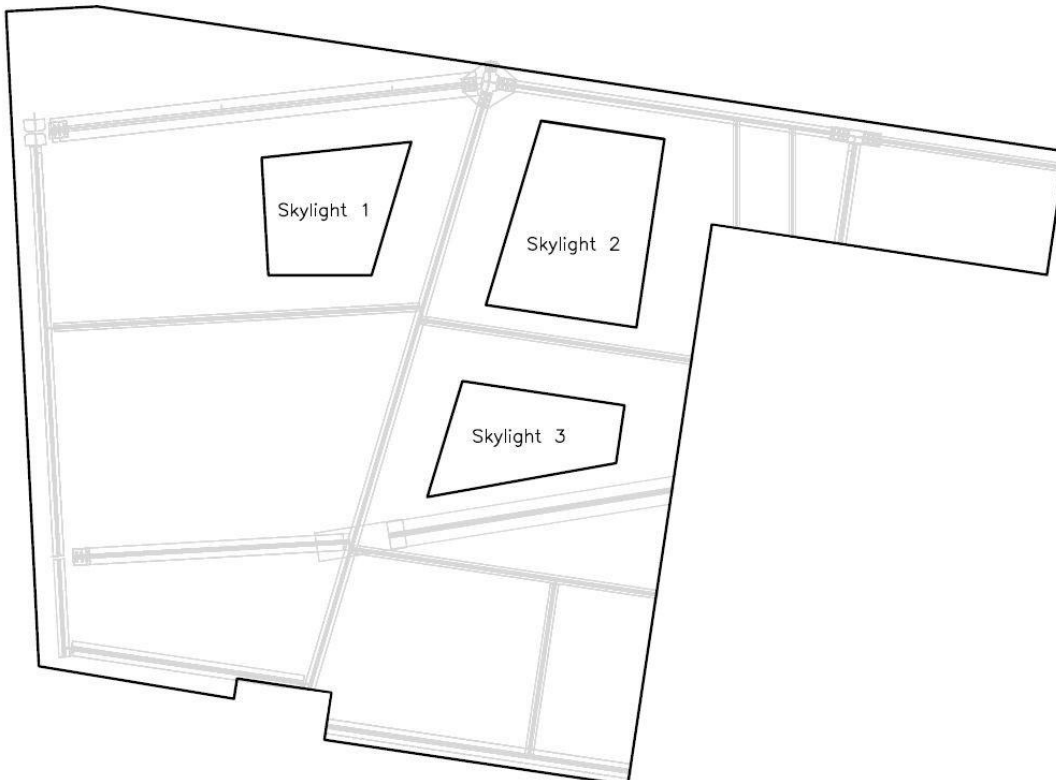
We see from the daylight autonomy plot below the distribution of percentage values of the points that meet the target illuminance across the year. As expected, the points closest to the window meet the target illuminance more times throughout the year than do points further from the window.



The plan below highlights the portion of the space that reaches the target illuminance only a small portion of the year. This area shall be deemed the **critical zone**. The skylights should be designed so as to provide illuminance to the critical zone to supplement the shading system.



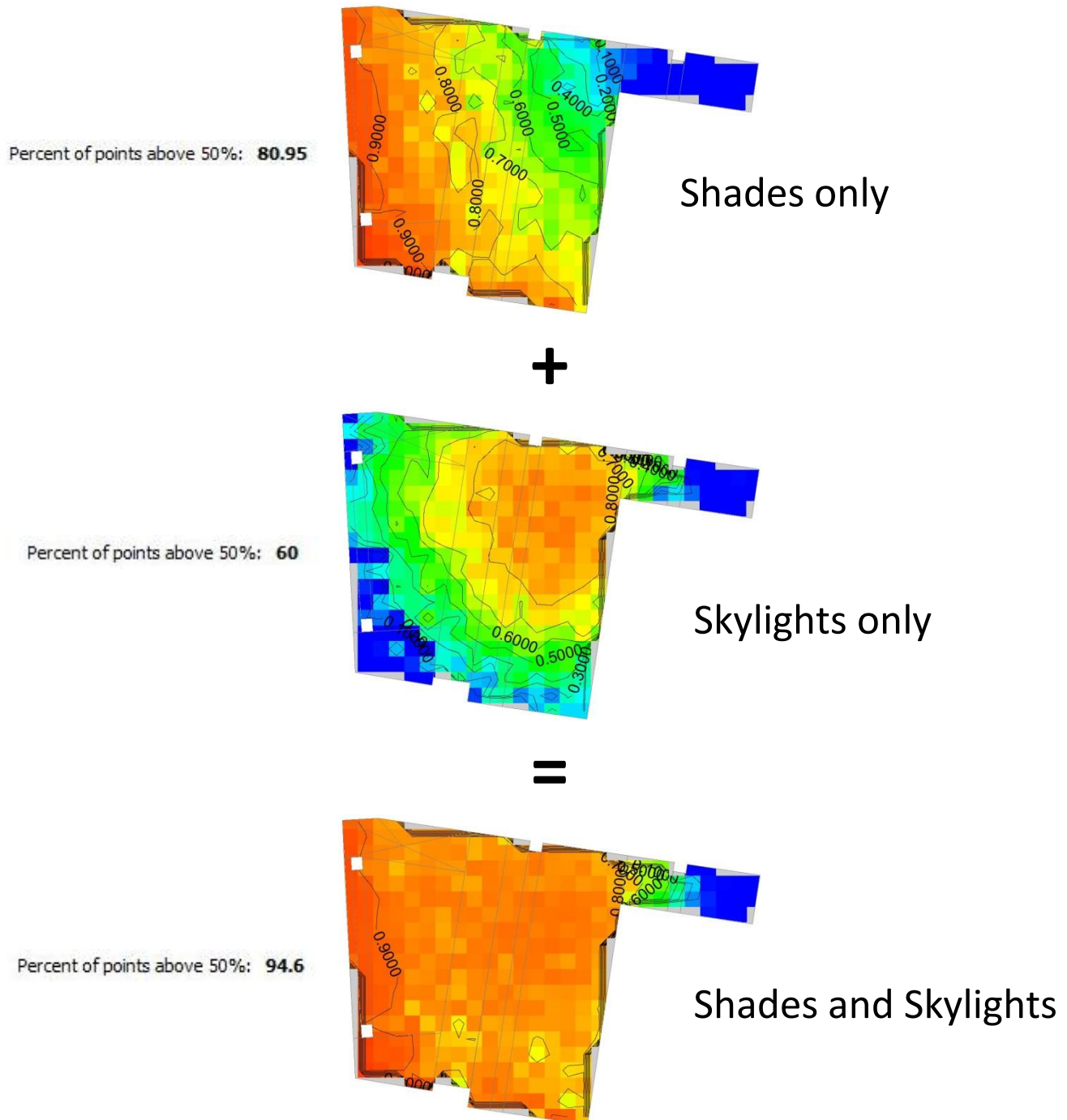
Considering both the need for illuminance in the critical zone, and the layout of the structural system in the space, the following skylighting design is implemented:



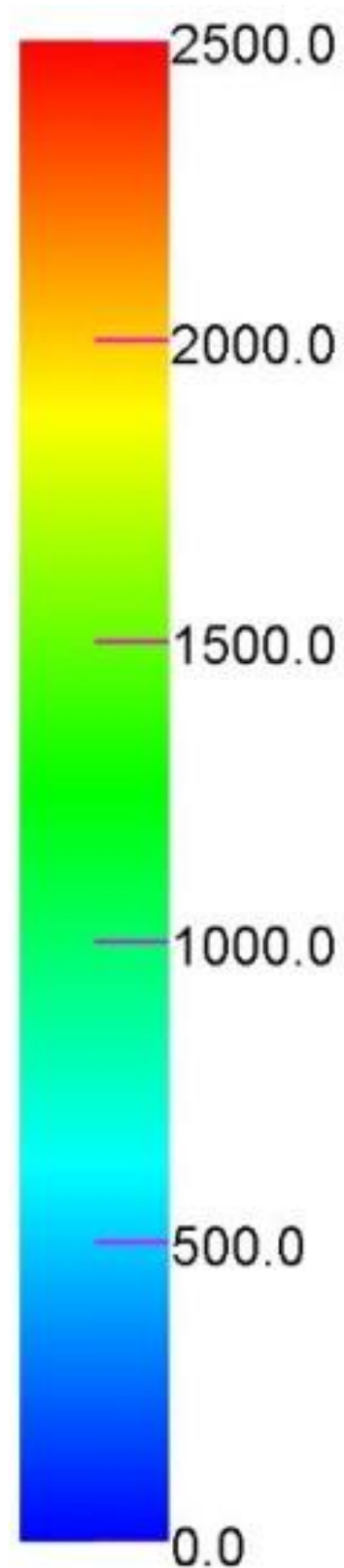
The figures below show, both graphically and mathematically, the calculation of daylight autonomy of the complete system (shades and skylights). Please note that the formula below should not be taken literally—i.e. the daylight autonomy values are not linearly additive due to overlap in percentages. The formula is merely a way to quantitatively represent the addition shown via the images.

$$(DA_{250lux,50\%})_{shades\ and\ skylights} = (DA_{250lux,50\%})_{shades\ only} + (DA_{250lux,50\%})_{skylights\ only}$$

$$(DA_{250lux,50\%})_{shades\ and\ skylights} =$$



Step 3: Compare daylight distribution in space



Step 3 is more of an analysis rather than a step that needs to be carried out. The previous step has shown the performance of the complete system—which includes both shades and skylights—via the daylighting metric Daylight autonomy. Daylight autonomy alone isn't sufficient information to determine if a system is performing preferably. In addition we shall look to analyze the distribution and penetration of daylight in the space.

This analysis is broken into two separate sections. Each section represents a different time of year, and thus, different sun and sky conditions. Within each section there are two images per row. Each row represents a single hour; the left image represents the space with just the shading system, and the right image shows the space with both the shades and skylights. They are organized this way so that a side-by-side comparison may be made, easily, at each hour of the day. This layout allows for easy comparison and as such, easy determination if the addition of the skylights is effective. The two sections, each representing a different time of year, are as follows:

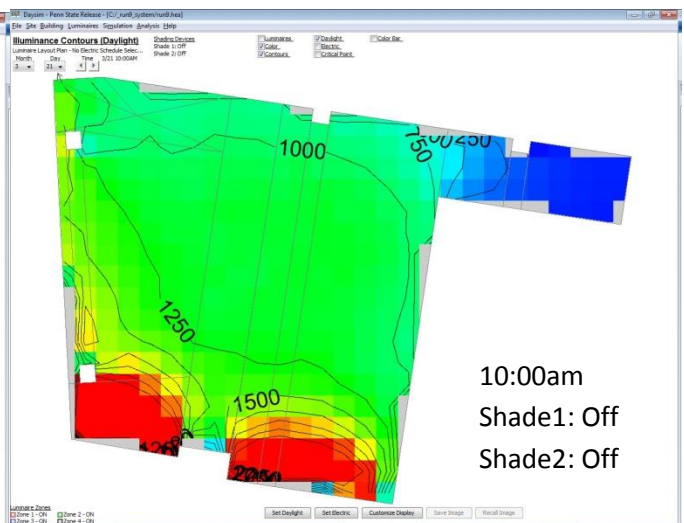
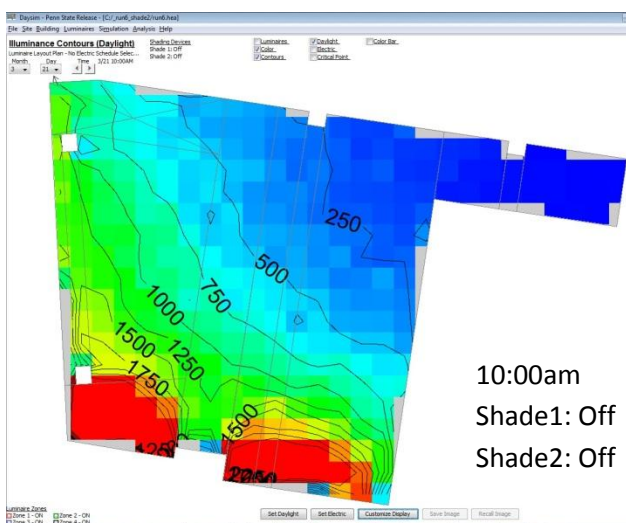
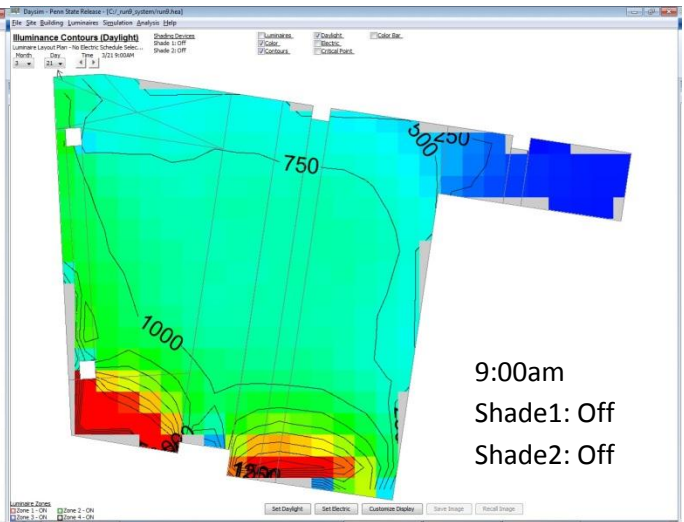
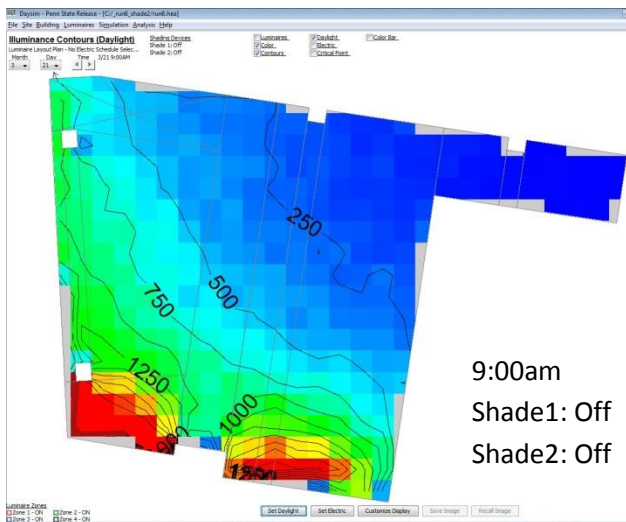
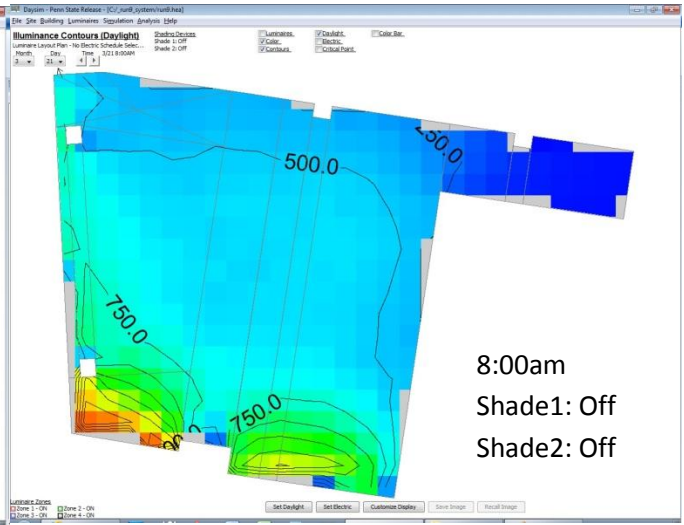
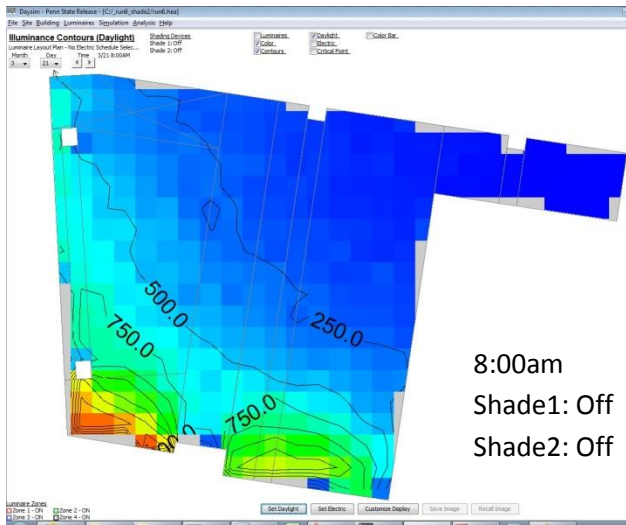
1. **Equinox:** March 21, 2012
2. **Winter Solstice:** December 21, 2012

The summer solstice is not presented as it is likely that the high school art room will be unoccupied during the summer.

Equinox, March 21: Shades Only vs. Shades and Skylights

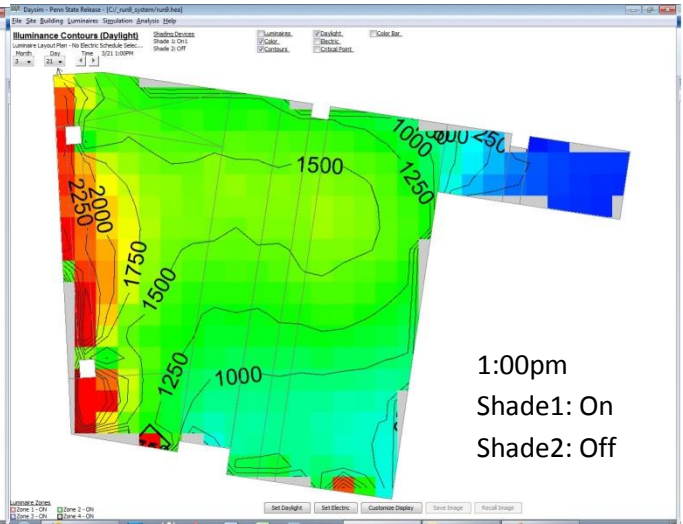
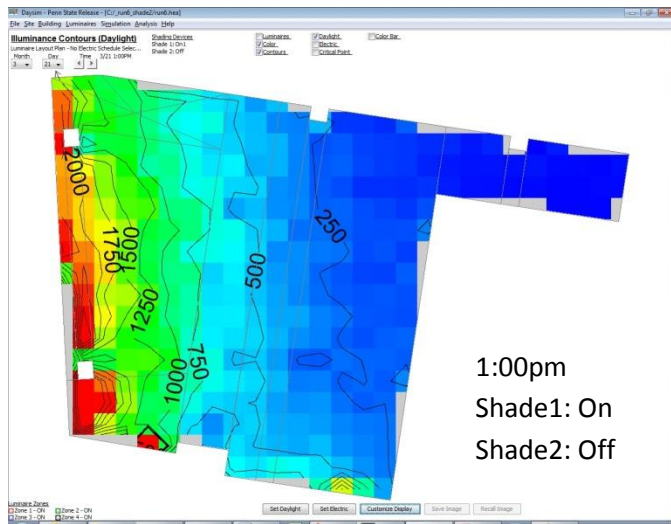
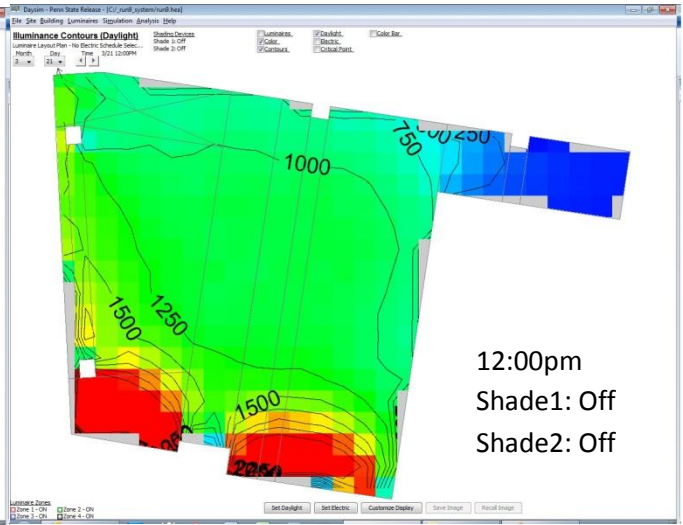
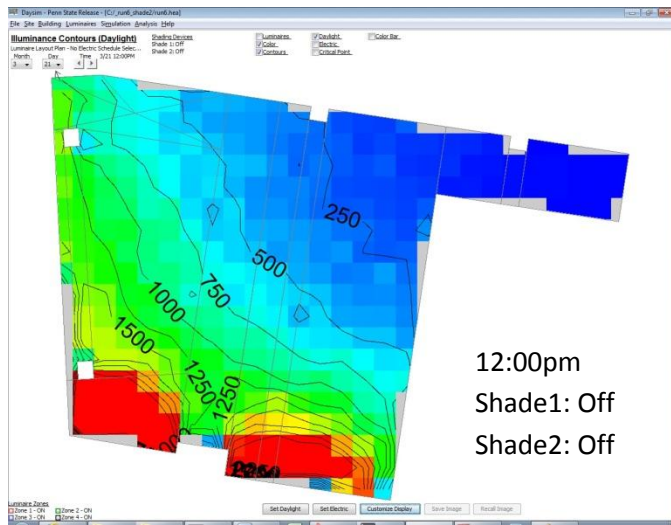
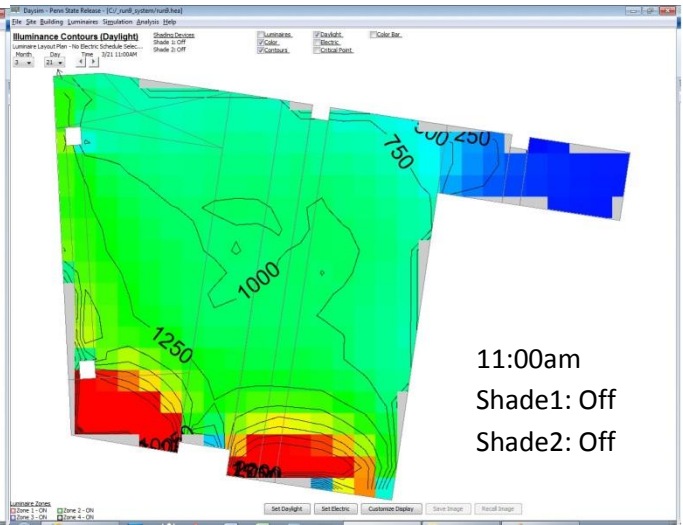
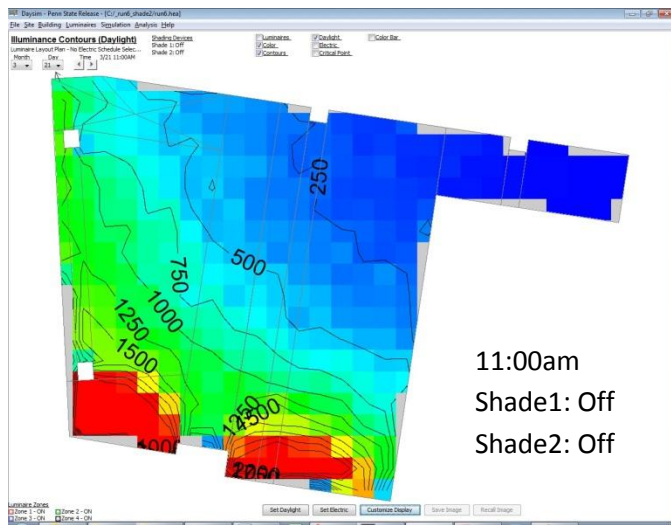
Shades Only

Shades and Skylights



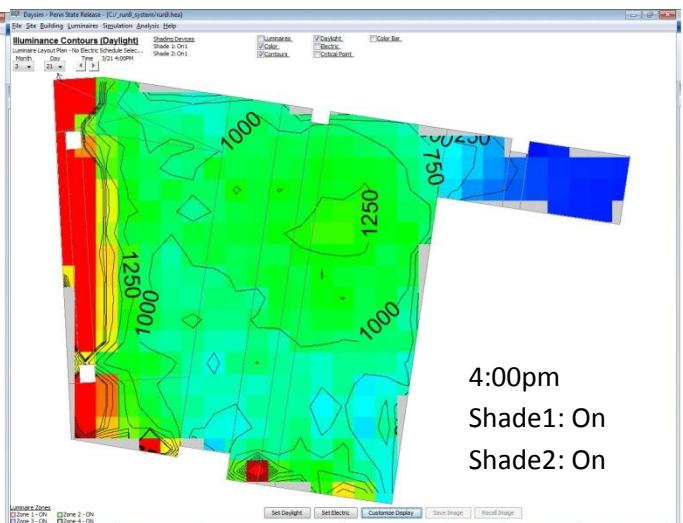
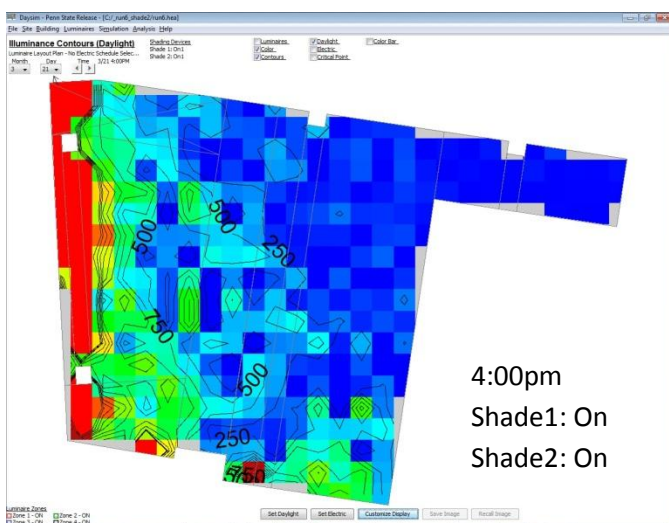
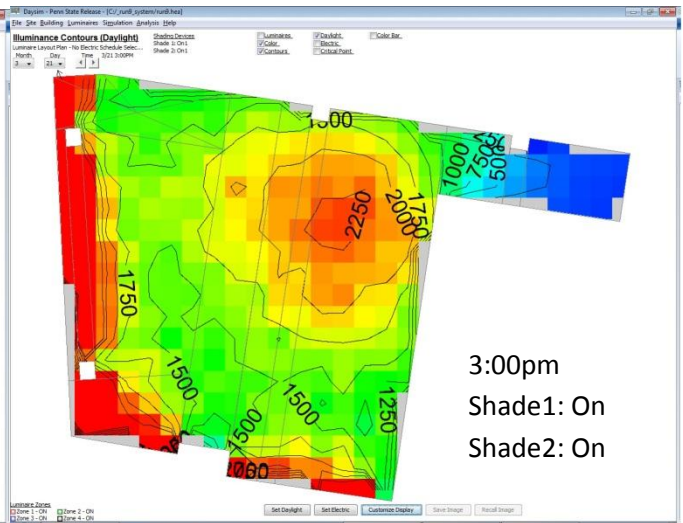
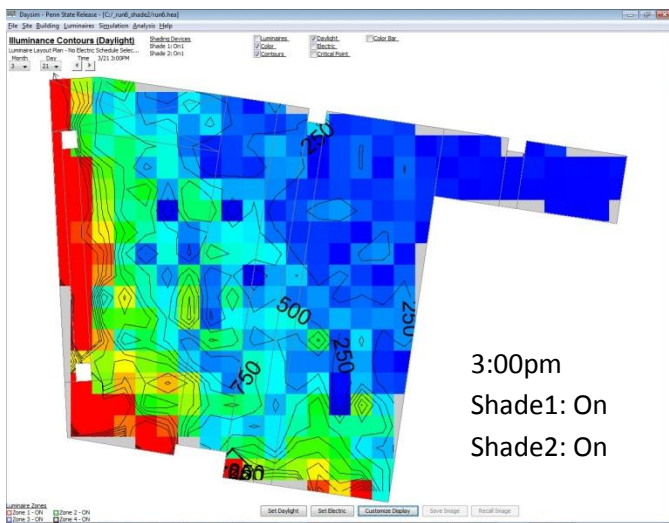
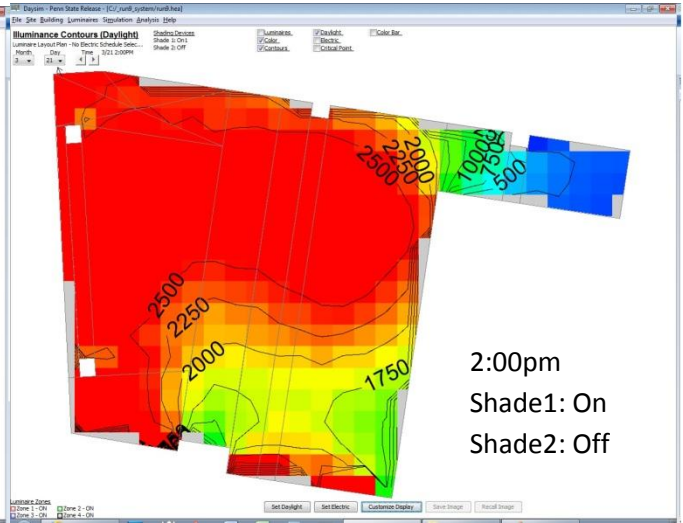
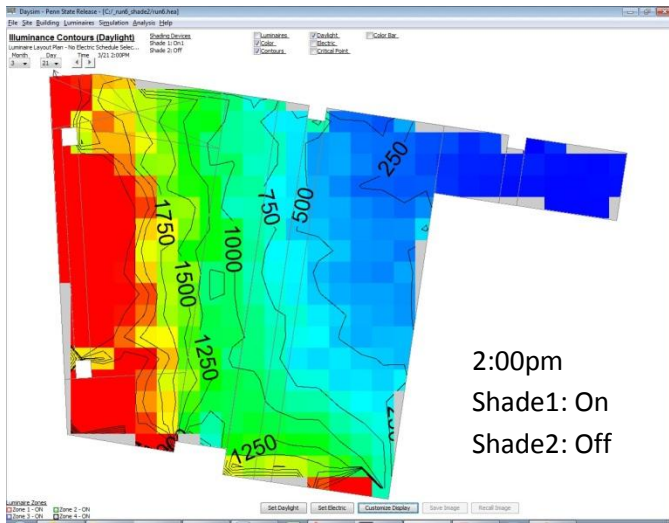
Shades Only

Shades and Skylights



Shades Only

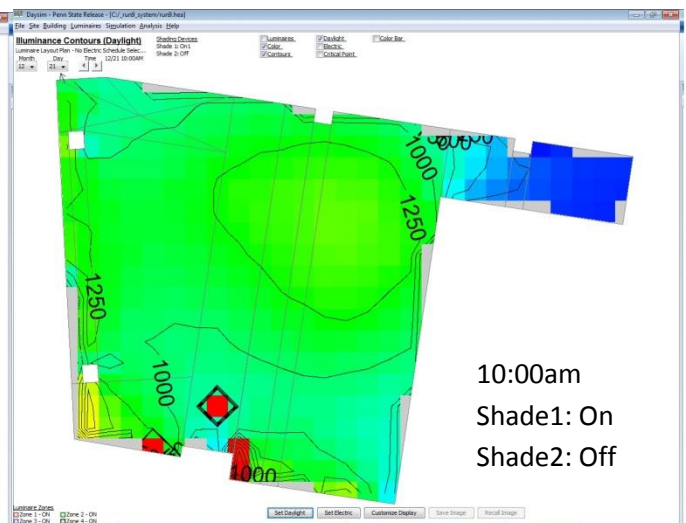
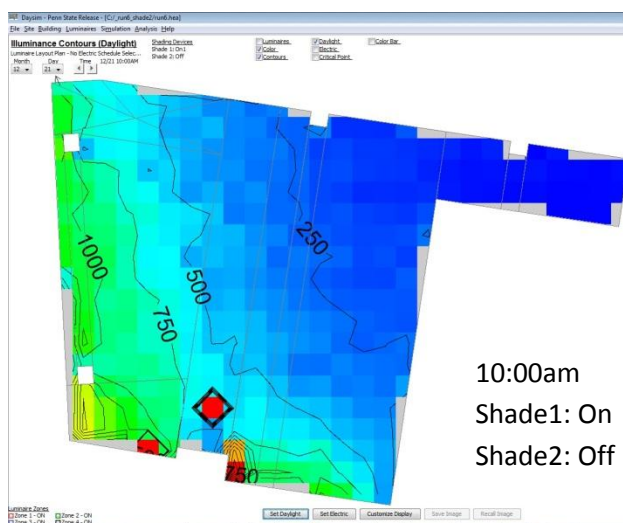
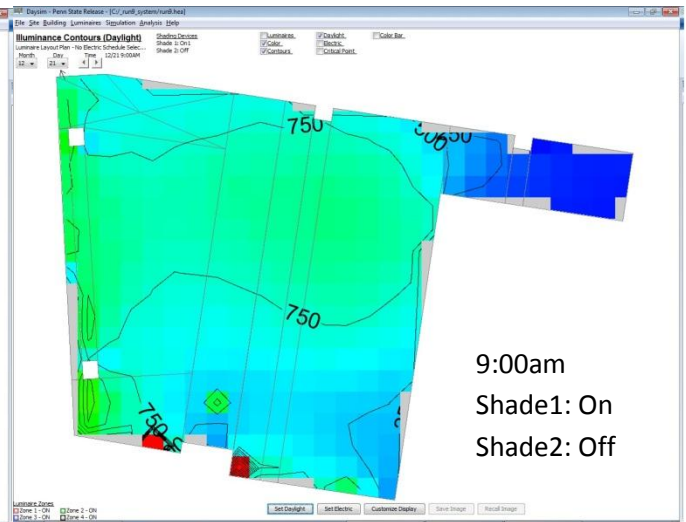
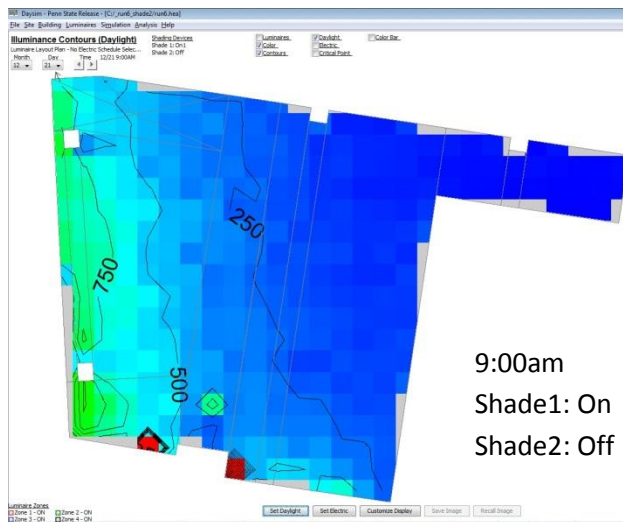
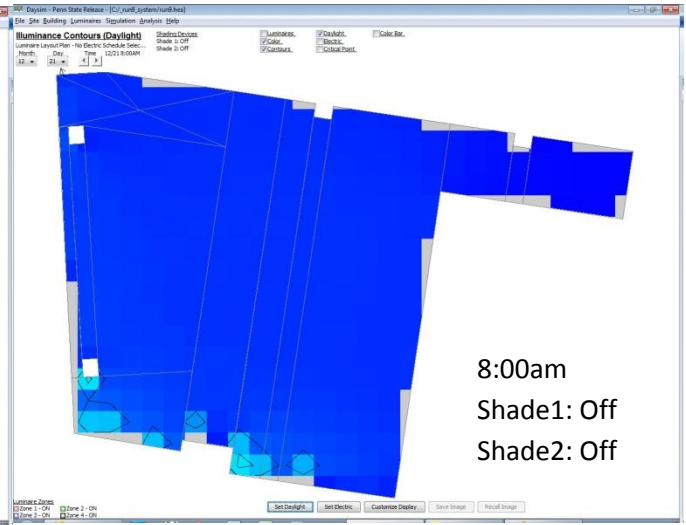
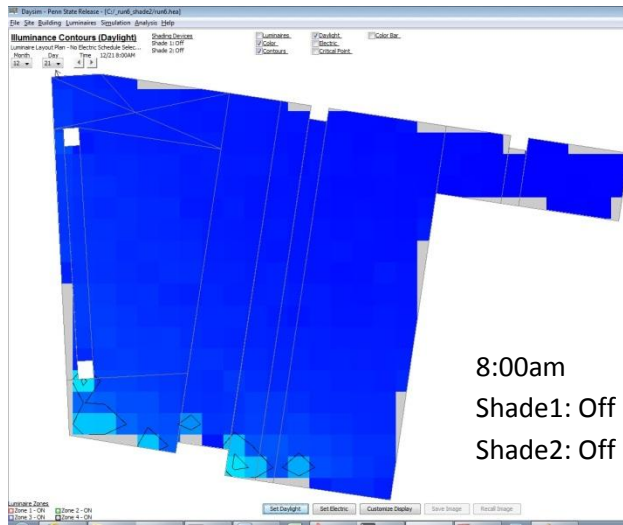
Shades and Skylights



Winter Solstice, December 21: Shades Only vs. Shades and Skylight

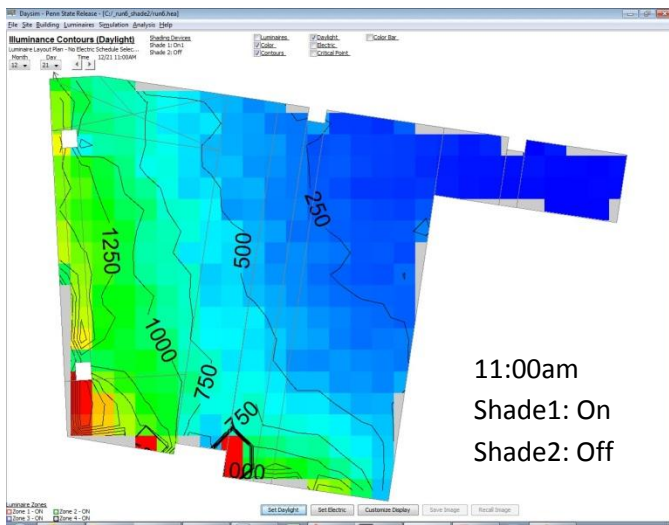
Shades Only

Shades and Skylights

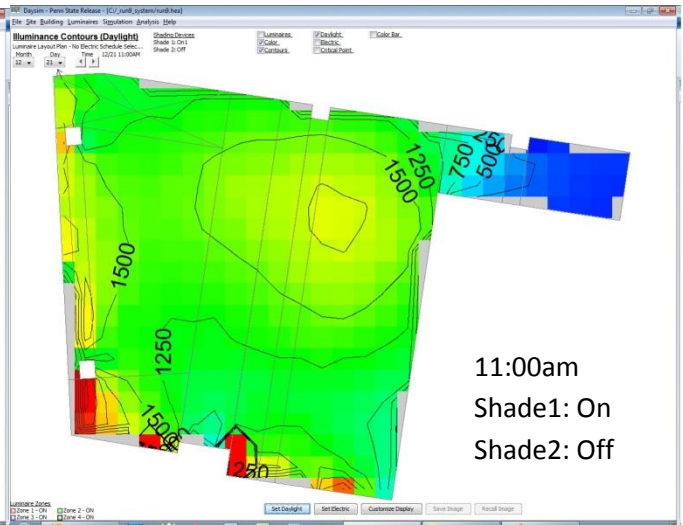


Shades Only

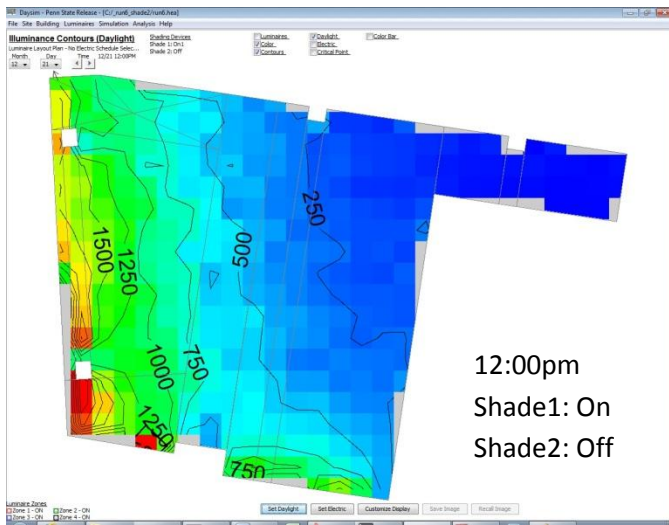
Shades and Skylights



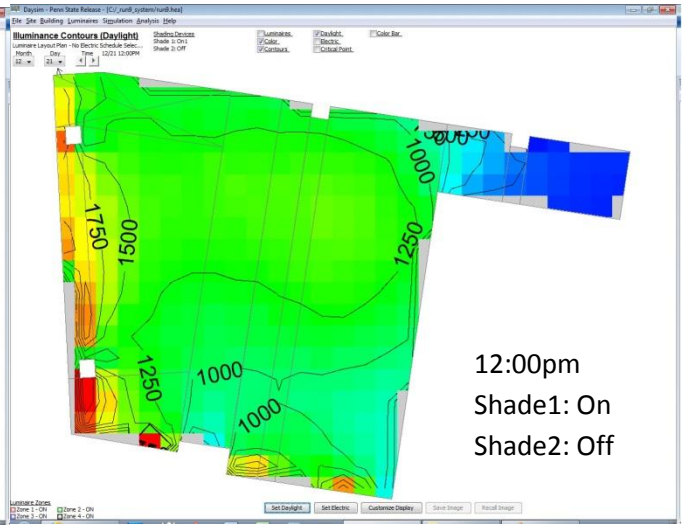
11:00am
Shade1: On
Shade2: Off



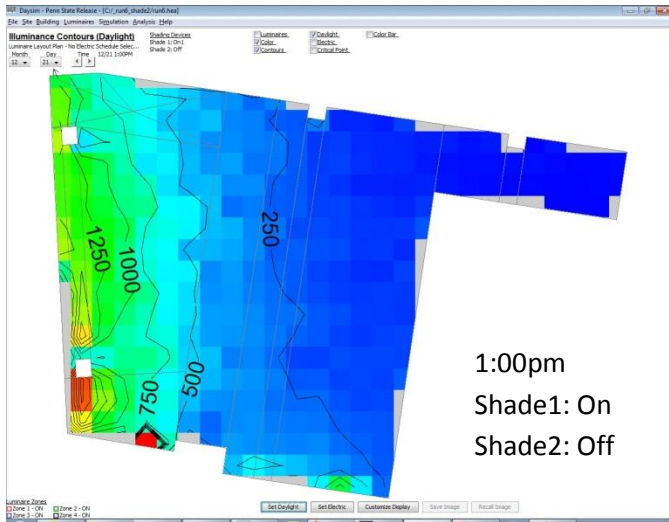
11:00am
Shade1: On
Shade2: Off



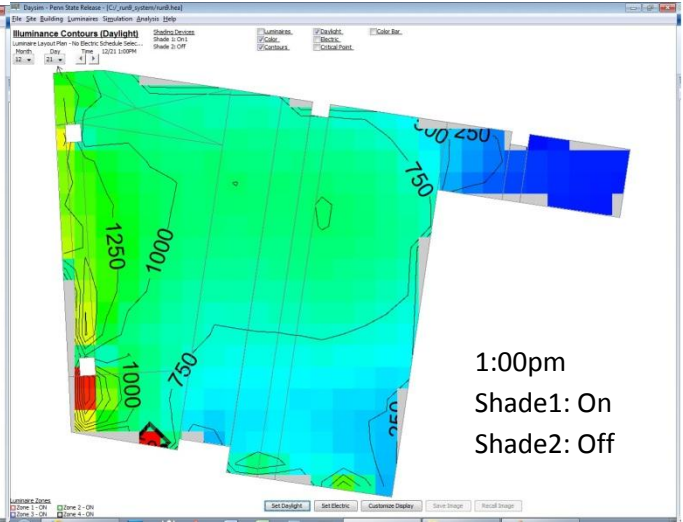
12:00pm
Shade1: On
Shade2: Off



12:00pm
Shade1: On
Shade2: Off



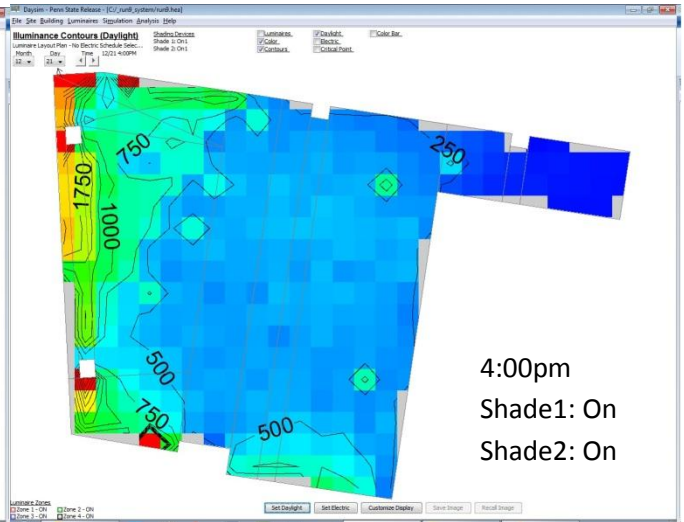
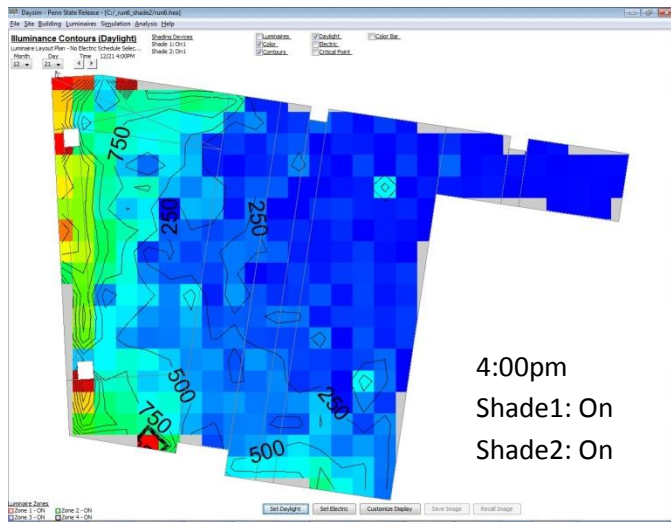
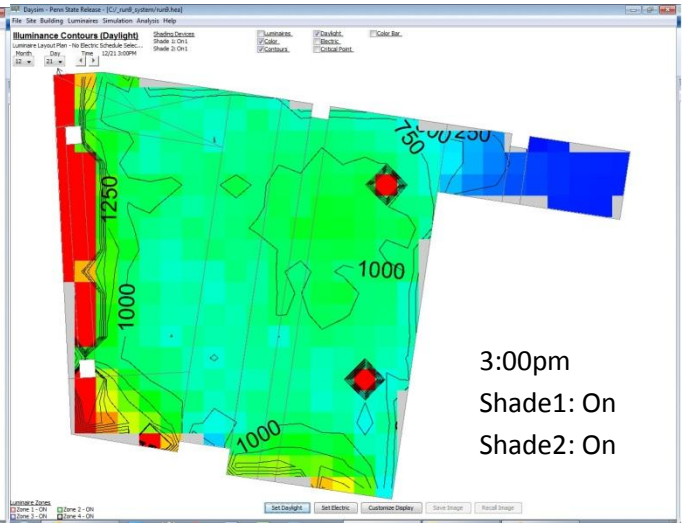
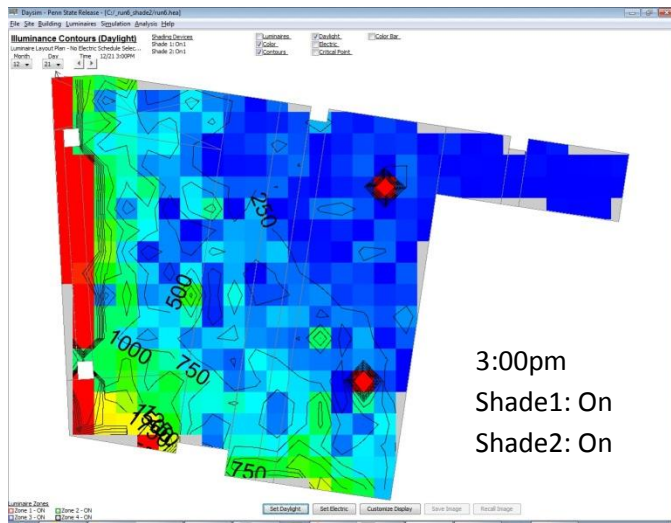
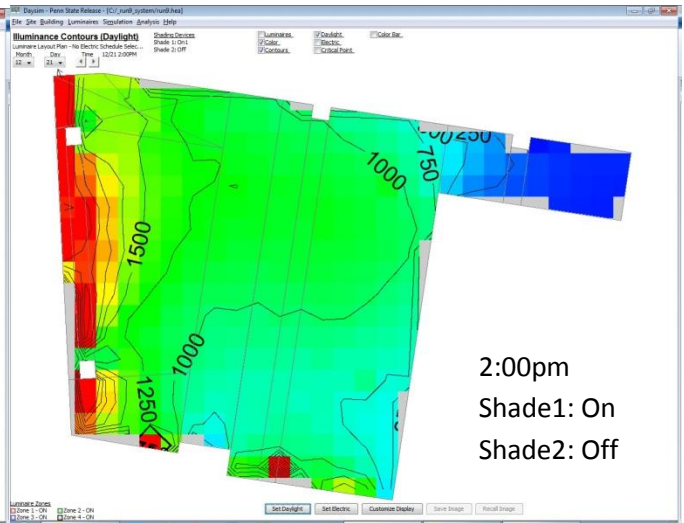
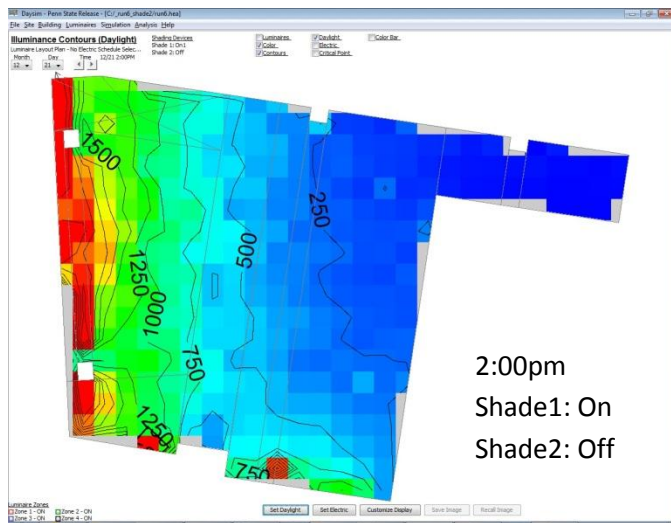
1:00pm
Shade1: On
Shade2: Off



1:00pm
Shade1: On
Shade2: Off

Shades Only

Shades and Skylights



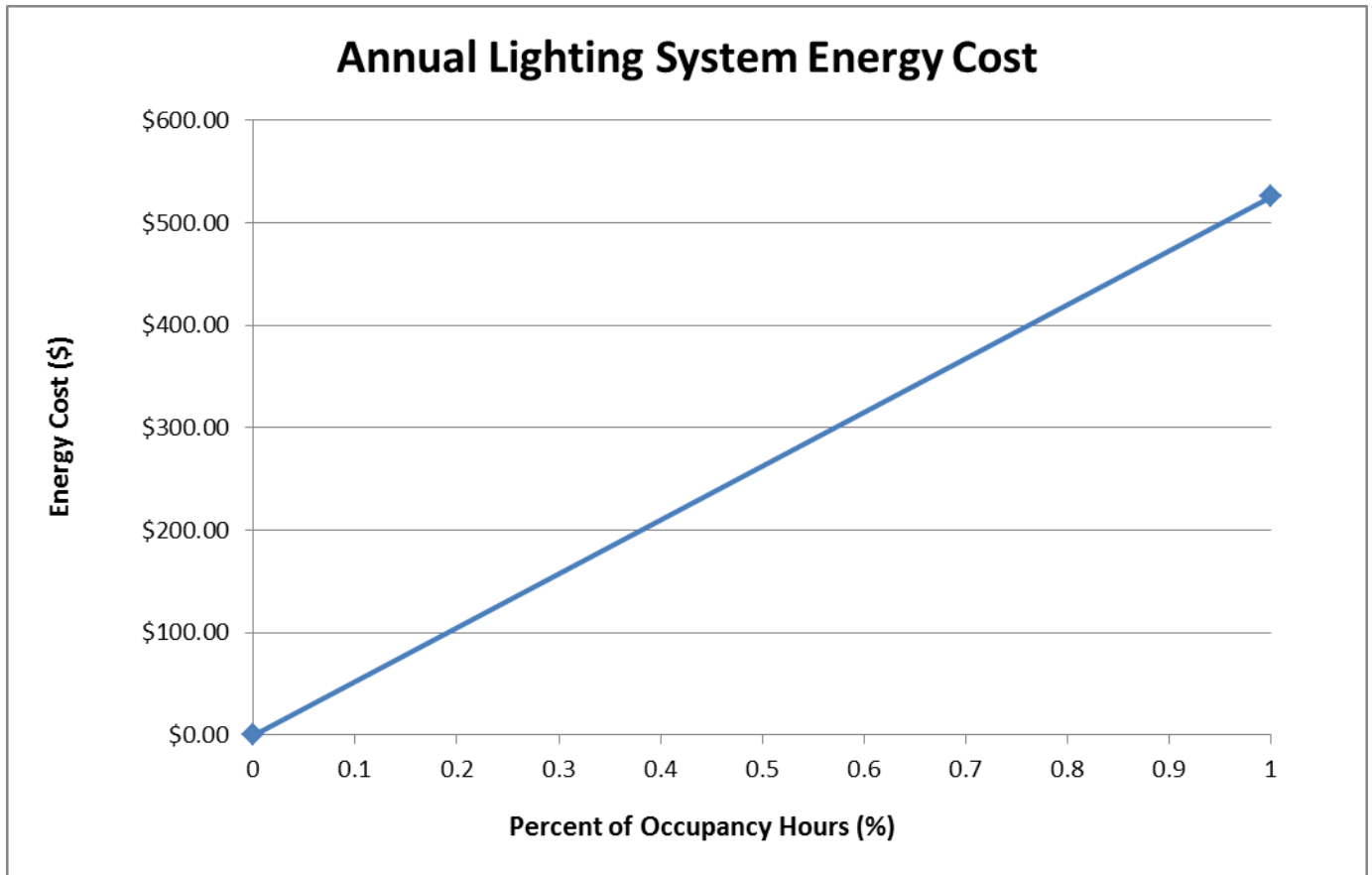
Step 4: Analyze Cost Implications

The table below shows the total cost of the lighting system based on the percentage of occupancy hours that the lighting is switched on. For example:

- **% Occupancy Hours = 1** , Lighting is on 100% of the occupancy schedule, and the lighting system is at full price
- **% Occupancy Hours = 0.5**, Lighting is on 50% of the occupancy schedule, and the annual lighting system saves 50% of the annual price
- **% Occupancy Hours = 0**, Lighting is always turned off, and the annual cost of the lighting system is \$0.00

The graph on the next page represents the data from the table below, graphically. The graph alone has little significance until the electrical lighting savings can be compared against the mechanical equipment operating energy costs. This analysis and break-even point are presented in the Mechanical Breadth section.

Lighting Energy Cost by Percent Occupancy hour					
% Occupancy Hours	Input kW	Total Occupancy Hours	\$/kWh	Total kWh	\$
1	0.964	2727	0.2	2628.828	525.7656
0.95	0.964	2727	0.2	2497.3866	499.47732
0.9	0.964	2727	0.2	2365.9452	473.18904
0.85	0.964	2727	0.2	2234.5038	446.90076
0.8	0.964	2727	0.2	2103.0624	420.61248
0.75	0.964	2727	0.2	1971.621	394.3242
0.7	0.964	2727	0.2	1840.1796	368.03592
0.65	0.964	2727	0.2	1708.7382	341.74764
0.6	0.964	2727	0.2	1577.2968	315.45936
0.55	0.964	2727	0.2	1445.8554	289.17108
0.5	0.964	2727	0.2	1314.414	262.8828
0.45	0.964	2727	0.2	1182.9726	236.59452
0.4	0.964	2727	0.2	1051.5312	210.30624
0.35	0.964	2727	0.2	920.0898	184.01796
0.3	0.964	2727	0.2	788.6484	157.72968
0.25	0.964	2727	0.2	657.207	131.4414
0.2	0.964	2727	0.2	525.7656	105.15312
0.15	0.964	2727	0.2	394.3242	78.86484
0.1	0.964	2727	0.2	262.8828	52.57656
0.05	0.964	2727	0.2	131.4414	26.28828
0	0.964	2727	0.2	0	0



Conclusion

Evaluating all presented information, it is reasonable to say that the skylighting system and layout has been effective. Looking at daylight autonomy we see that the number of points across the year that meet the target illuminance of 250 lux, which is between 80-90% for all points, is very reasonable for a daylit space. Comparing the illuminance distribution of the skylighting and shades combination system against the base case of just shades (Step 3), we see the over parts of the year the skylights are effective and sometimes they are not. However, more times than not, they supplement the shading system in not only reaching the target illuminance of the space, but also creating a more uniform illuminance distribution.

The cost payback, as will be discussed in the price implications section of the mechanical breadth, will show that the electric lighting system needs to be shut off approximately 40% of the occupancy schedule to break even. This is reasonable. The tables at the end of Step 1 show that no shades are down approximately 40% of the occupancy schedule. As the system is designed no electric light during time of open shades, it is likely that the space will produce (at minimum) break-even energy costs.

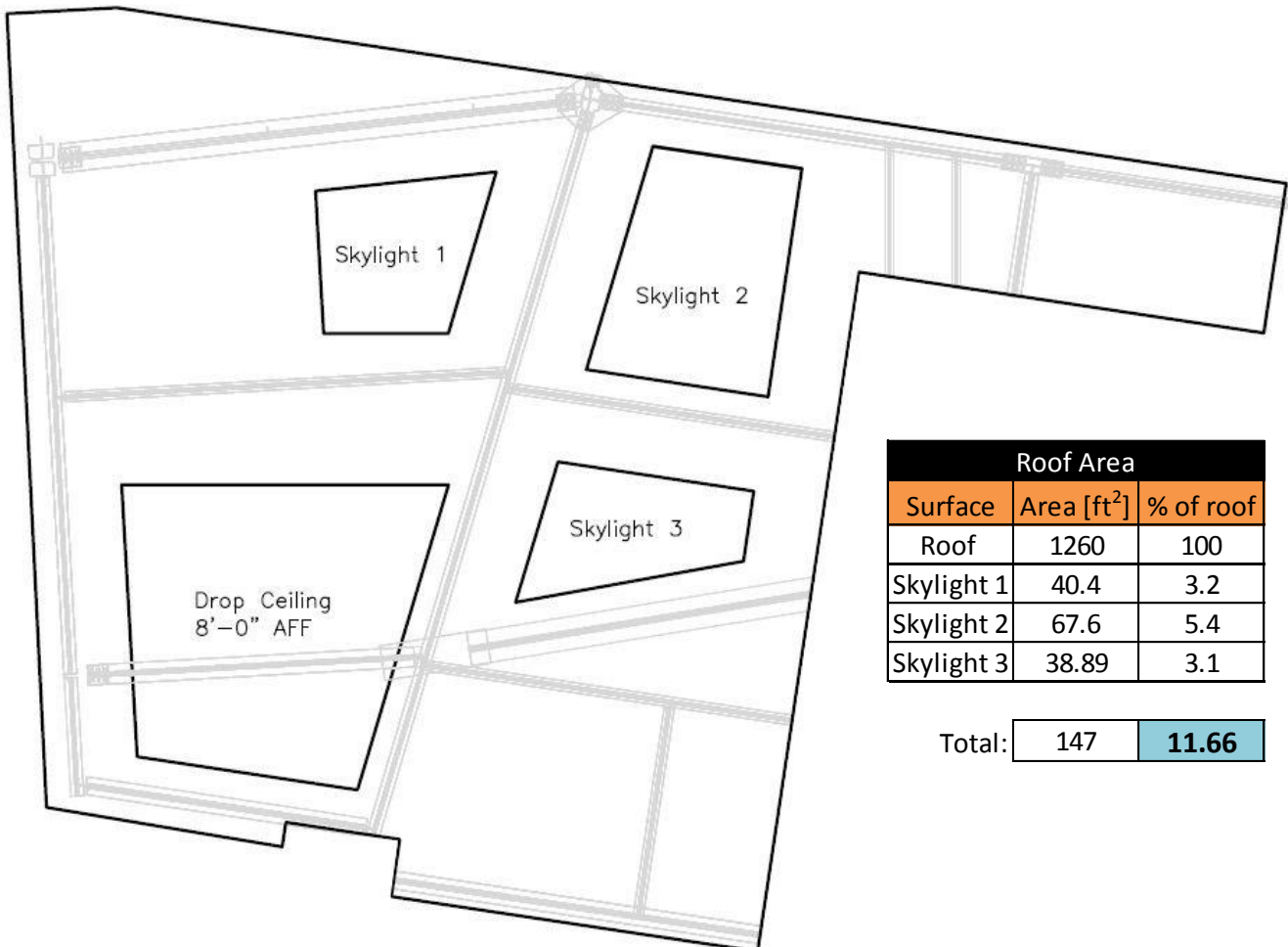
Breadth two | Mechanical load

Introduction

The previously presented breadth, the MAE daylighting analysis of the High School Art Room, poses a slight problem that needs to be addressed. The skylights that were installed to provide useful daylight will also produce additional, undesirable, load on the heating and cooling systems. In the winter, heat loss through the skylights must be replaced by the heating system, which for the High School Art Room, is comprised of fin tube radiators lining the perimeter of the space. In the summer, heat gain through the skylights must be combatted by the cooling system, which for this building, is by overhead ductwork and diffusers. This breadth topic will present the findings of analyses that were aimed to answer the following two questions:

1. **Heating:** Are the fin tube radiators large enough to replenish the heat lost through the skylights?
2. **Cooling:** Is the existing cooling system (ductwork) capable of cooling the addition heat introduced into the space by the skylights?

The image below shows the ceiling plan of the High School Art Room with the skylights shown. The table shown with the plan gives the area of each skylight, as well as the percentage of the roof it occupies.



Heating | Fin Tube Radiator

The HS Art Room is heated with a fin tube radiator system which lines the two exterior perimeter walls. In addition to the fin tube radiators, a unit heater located near the door provides additional heating. The goal is thus to determine if the fin tubes and unit heater are sufficiently sized to handle the additional (heating) load resulting from the introduction of the skylight system. The following steps to determine this are as follows:

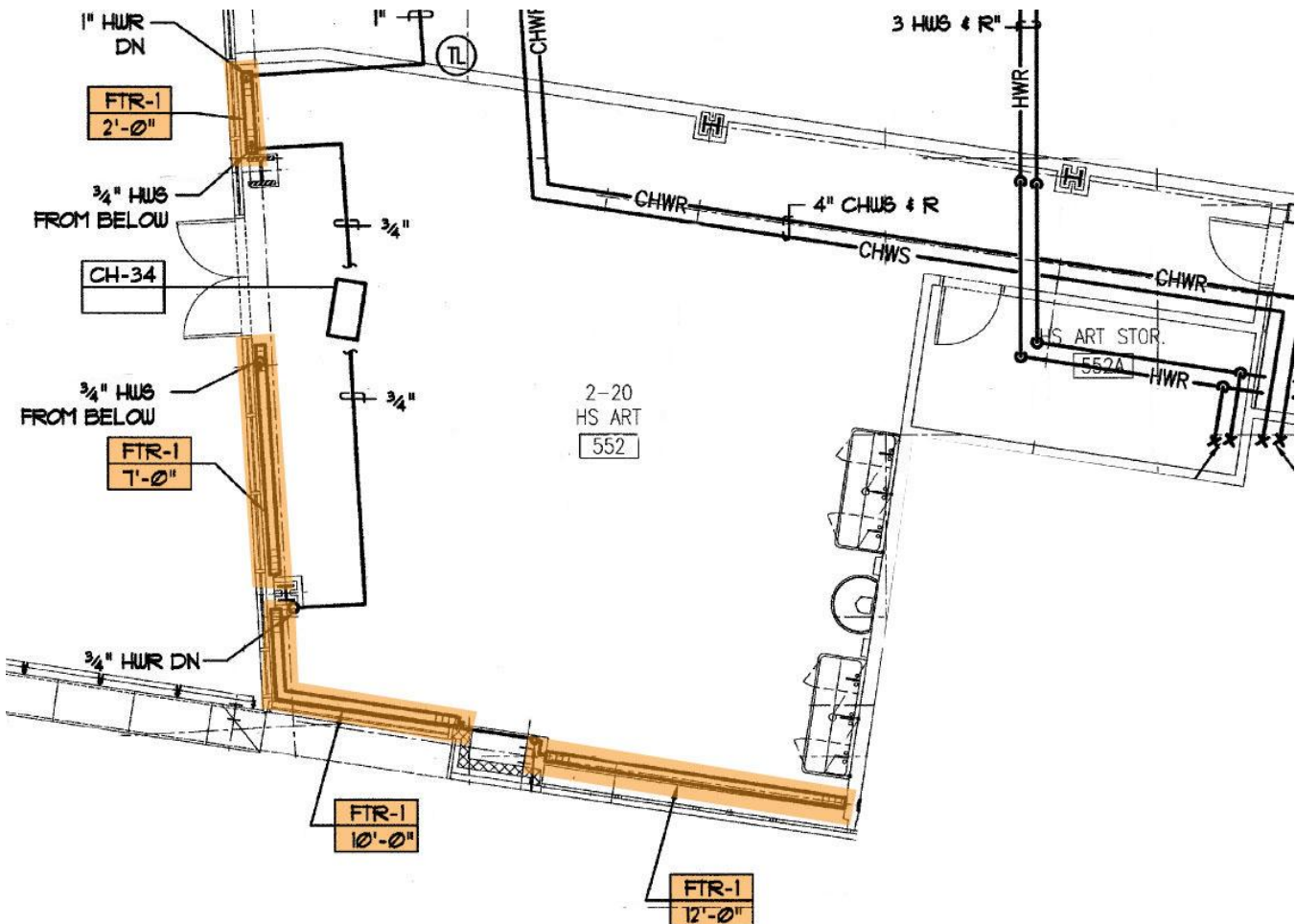
- Step 1: Calculate total space heating **capacity**
- Step 2: Determine air supply **induced heating load**
- Step 3: Calculate skylight **heat loss**.
- Step 4: Determine if existing fin tubes are **sufficient** for new load

Step 1: Calculate total space heating capacity

Total space heating capacity = Fin tube heater capacity + Cabinet Unit heater capacity

To find the capacity of the fin tube heater we first have to find the total length of the fin tubes in the room. Adding the length of the fin tubes counter-clockwise on the plan below we have:

$$\text{Total Fin tube length} = 2'-0'' + 7'-0'' + 10'-0'' + 12'-0'' = 31'-0''$$

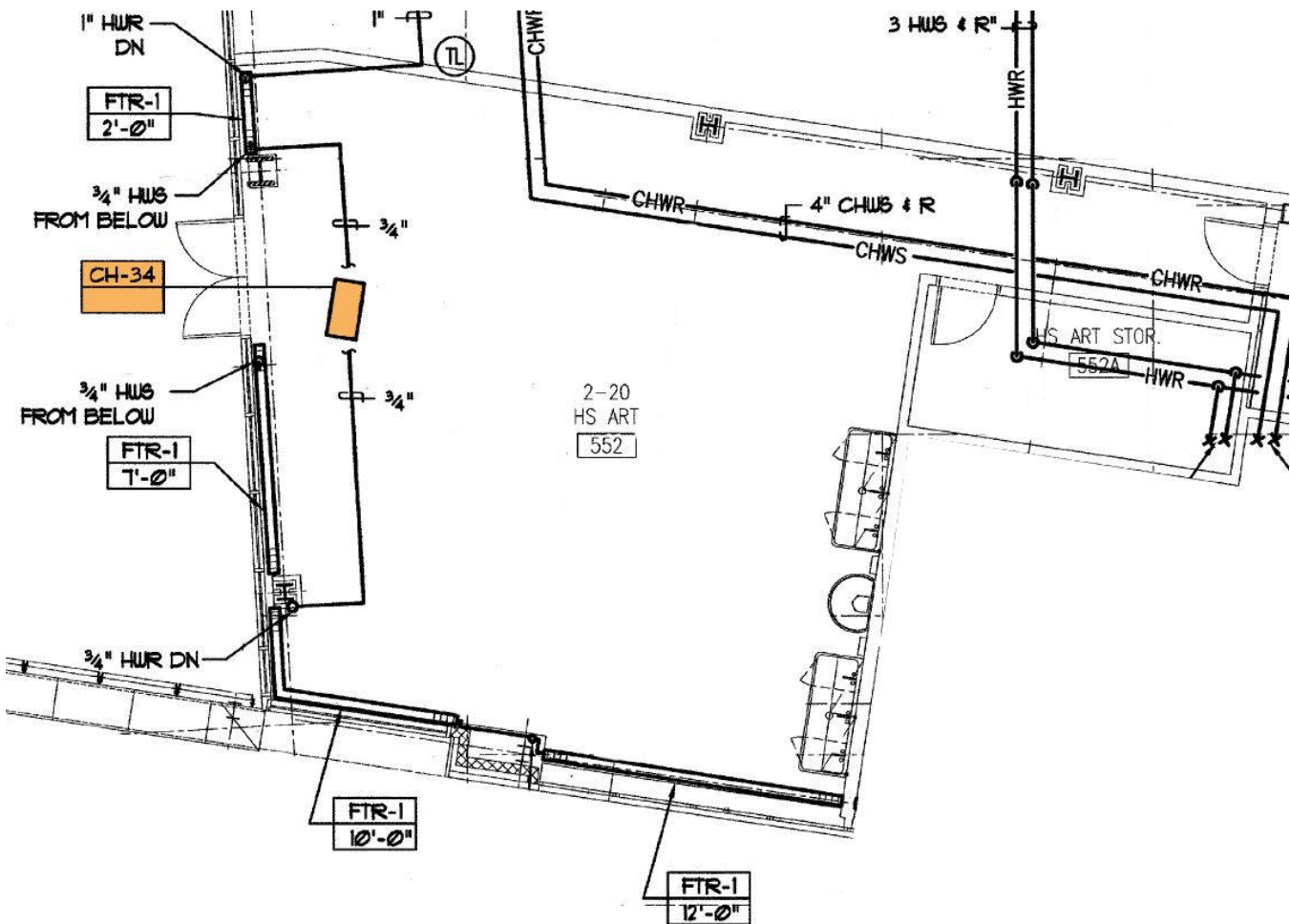


With the total length of the fin tubes known, we can calculate the total heating capacity of the fin tubes. The table below shows that the fin tube of type FTR-1 (that which serves this particular space) produces **690 BTU/ft.** Thus, the total heating capacity of the fin tube radiators in this space is:

Total fin tube heating capacity = (31 feet) * (690 BTU/feet) = 21, 390 BTU's

FIN TUBE RADIATION SCHEDULE														
TYPE	MANUFACTURER	MODEL	ELEMENT						AVERAGE TEMP. °F	EAT °F	BTUH PER LIN. FT.	DAMPER	ENCLOSURE MTG. HT. - IN.	
			MATERIAL	FIN THICKNESS	NO OF FINS PER FT.	FIN SIZE IN.	PIPE SIZE IN.	NO OF ROWS					FLOOR TO BOTTOM	BOTTOM TO TOP
FTR-1	VULCAN	D6 SLOPE TOP	COFFER-ALUMINUM	0.020"	48	4 1/2 x 4 1/2	1 1/4	2-12" CC	130	72	690	NO	SEE NOTE No. 1	24
FTR-2	VULCAN	D6 SLOPE TOP	COFFER-ALUMINUM	0.020"	48	4 1/2 x 4 1/2	1 1/4	1	130	72	520	NO	1	24
FTR-3	RUNAL	RC-10	COLD ROLLED STEEL	-	-	-	-	-	130	72	366	-	-	-

The second step in finding the total heating capacity of the system in the HS Art Room is to find the heating capacity of the unit heater CH-34 located in the space. The plan below shows the location of the unit heater near the door. The placement of the heater near the door helps prevent drafts in the space.



The schedule below shows the total heating capacity of the space unit heater, which is **7.9 MBH**.

CABINET & UNIT HEATER SCHEDULE											
GENERAL		UNIT DATA							MOTOR DATA		
UNIT NO.	SERVICE # LOCATION	MODEL NO	TYPE	CAP. MBH EACH • HIGH SPEED	CFM EACH	ROOM TEMP. °F	NO. OF COILS	HW GPM EACH	HP EACH	RFM (AT HIGH)	VOLTAGE PHASE HZ
CH-1 & 2	NORTH MAIN ENT. VESTIBULE (1ST FL.)	RC-1200-04	CEILING RECESSED	22.0	430/380	T2	2 ROW	2.3	1/8	1550	15/1/60
CH-3 & 4	SOUTH MAIN ENT. VESTIBULE (1ST FL.)	RC-1200-04	CEILING RECESSED	14.3	430/380	T2	STAND.	1.5	1/8	1550	15/1/60
CH-5	WEST ENT. (1ST FL.)	RC-1200-02	CEILING RECESSED	7.9	230/170	T2	STAND.	0.83	1/8	1550	15/1/60
CH-6	NORTH SERVICE ENT. (1ST FL.)	RC-1200-02	CEILING RECESSED	7.9	230/170	T2	STAND.	0.83	1/8	1550	15/1/60
CH-7	EAST ENT. (1ST FL.)	F-1000-02	FREE STANDING	7.9	230/170	T2	STAND.	0.83	1/8	1550	15/1/60
CH-8	OVERHUNG ON 2ND FLOOR	RC-1210-03	CEILING FULLY RECESSED	9.0	335/260	T2	STAND.	0.96	1/8	1550	15/1/60
CH-9 & CH-9 A	1/8 CAFE EXIT TO TERRACE (5TH FL.)	RC-1200-03	CEILING FULLY RECESSED	16.7	335/260	T2	2 ROW	1.8	1/8	1550	15/1/60
CH-10 & CH-10 A	1/8 CAFE EXIT TO TERRACE (5TH FL.)	RC-1200-03	CEILING FULLY RECESSED	16.7	335/260	T2	2 ROW	1.8	1/8	1550	15/1/60
CH-11	STAIR A VESTIBULE (ROOF)	F-1000-03	FREE STANDING	19.4	335/260	T2	STAND.	2.1	1/8	1550	15/1/60
CH-12 & 36	STAIR B (5TH FLOOR & 1ST FL.)	RW-1120-02	WALL RECESSED	7.9	230/170	T2	STAND.	0.83	1/8	1550	15/1/60
CH-13	STAIR A (5TH FLOOR)	F-1000-02	FREE STANDING	7.9	230/170	T2	STAND.	0.83	1/8	1550	15/1/60
CH-14,17,19,20,22,23,26,27,31 & 35	BOYS & GIRLS TOILET (1ST TO 5TH FL.)	RW-1120-02	WALL RECESSED	7.9	230/170	T2	STAND.	0.83	1/8	1550	15/1/60
CH-15 & 16	MEN'S & WOMEN'S SHOWER (5TH FL.)	RW-1120-02	WALL RECESSED	7.9	230/170	T2	STAND.	0.83	1/8	1550	15/1/60
CH-18	H8 STAFF LOCK (4TH FL.)	RC-1200-02	CEILING RECESSED	7.9	230/170	T2	STAND.	0.83	1/8	1550	15/1/60
CH-21	H8 STAFF LOCK (3RD FL.)	RC-1200-02	CEILING RECESSED	7.9	230/170	T2	STAND.	0.83	1/8	1550	15/1/60
CH-24 & 25	H8 STAFF LOCK (2ND FL.)	RF-131	WALL SEMI RECESSED	5.5	170 MAX.	T2	STAND.	1.0	1/70	VARI	15/1/60
CH-28	VISITOR LOCK (1ST FLOOR)	RC-1200-02	CEILING RECESSED	7.9	230/170	T2	STAND.	0.83	1/8	1550	15/1/60
CH-29 & 33	SHOWERS (1ST FL.)	RC-1200-02	CEILING RECESSED	7.9	230/170	T2	STAND.	0.83	1/8	1550	15/1/60
CH-30 & 32	LOCKER ROOM (1ST FL.)	RC-1200-02	CEILING RECESSED	7.9	230/170	T2	STAND.	0.83	1/8	1550	15/1/60
CH-34	H8 ART (5th FL.)	RC-1200-02	CEILING FULLY RECESSED	7.9	230/170	T2	STAND.	0.83	1/8	1550	15/1/60
CH-36 & 38	STAIR A & B (1ST FL.)	RW-1120-03	WALL RECESSED	9.0	335/260	T2	STAND.	0.96	1/8	1550	15/1/60
CH-37	STAIR C (1ST FL.)	RC-1200-02	CEILING RECESSED	7.9	230/170	T2	STAND.	0.83	1/8	1550	15/1/60
CH-39	16 BOY'S LOCKER RM. (1ST FL.)	RC-1200-02	CEILING RECESSED	7.9	230/170	T2	STAND.	0.83	1/8	1550	15/1/60
CH-40	SCHOOL SAFETY OFFICE (1st FL.)	RF-131	WALL SEMI RECESSED	5.5	170 MAX.	T2	STAND.	1.0	1/70	VARI	15/1/60
UH-1	GROUND EQUIPMENT STORE ROOM #21	HV-108A	HORIZONTAL UNIT HEATER	5.0	245	T2	-	0.53	9 WATTS	1550	15/1/60

Now that the heating capacity for the fin tube radiators and space unit heater are known, we can calculate the total heating capacity of the space. Thus, we have:

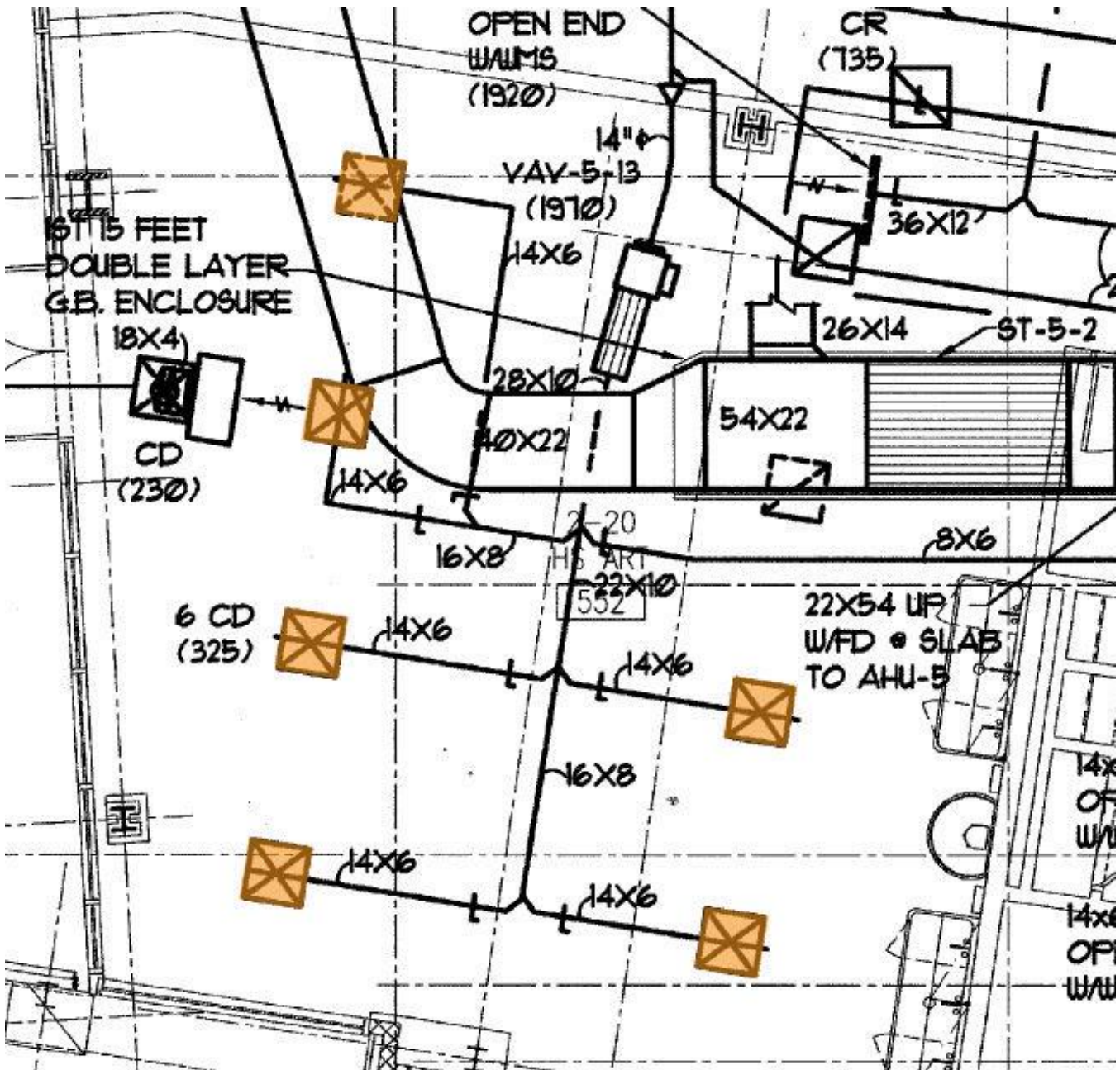
Total space heating capacity = Fin tube heater capacity + Cabinet Unit heater capacity

$$\text{Total space heating capacity} = (21,290 \text{ BTU/hr}) + (7.9 \text{ MBH}) * (1000 \frac{\text{BTU/hr}}{\text{MBH}}) = 29,290 \text{ BTUs/hr.}$$

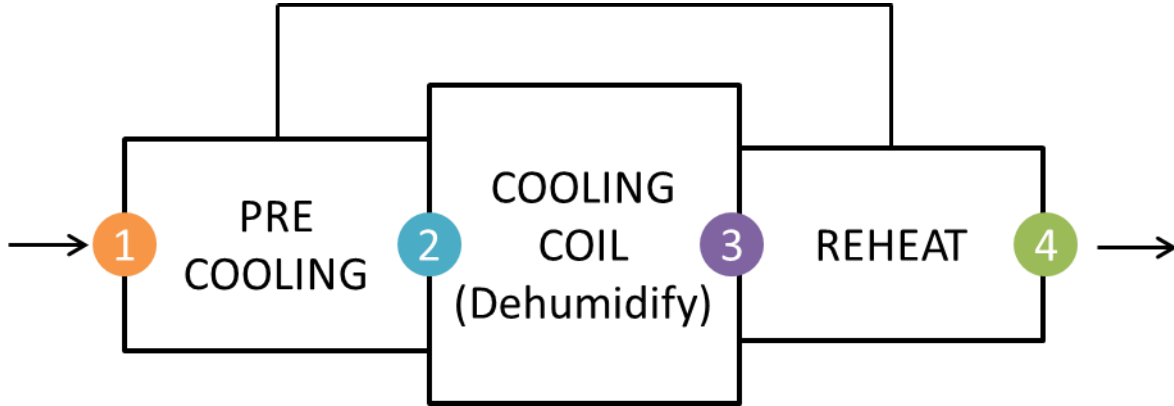
Step 2: Air supply induced heating load

Now that we know the load capacity of the mechanical heating system for the High School Art Room, we have to calculate the total heating load required for the space. In the winter months, the supply air from the ductwork system is at a temperature below that of the desire room set-point temperature. As a result, ironically, the cooling system introduces an additional load on the heating system. To calculate this load, we first need to calculate the total air flow the system is providing. The six supply diffusers are highlighted in orange on the mechanical plan below. Each of these provides 325 CFM to the space. Thus, we have:

Total air flow to space = (325 CFM/Diffuser) * (6 Diffusers) = 1950 CFM_{supply}



The next step is to determine the change in temperature. We know from good mechanical design practice that the winter set point temperature is 72 degrees. The mystery in finding the change in temperature is finding the temperature the air is supplied at. The mechanical system in this building utilized a wrap-around heat pump, schematic heat pump diagram show below.



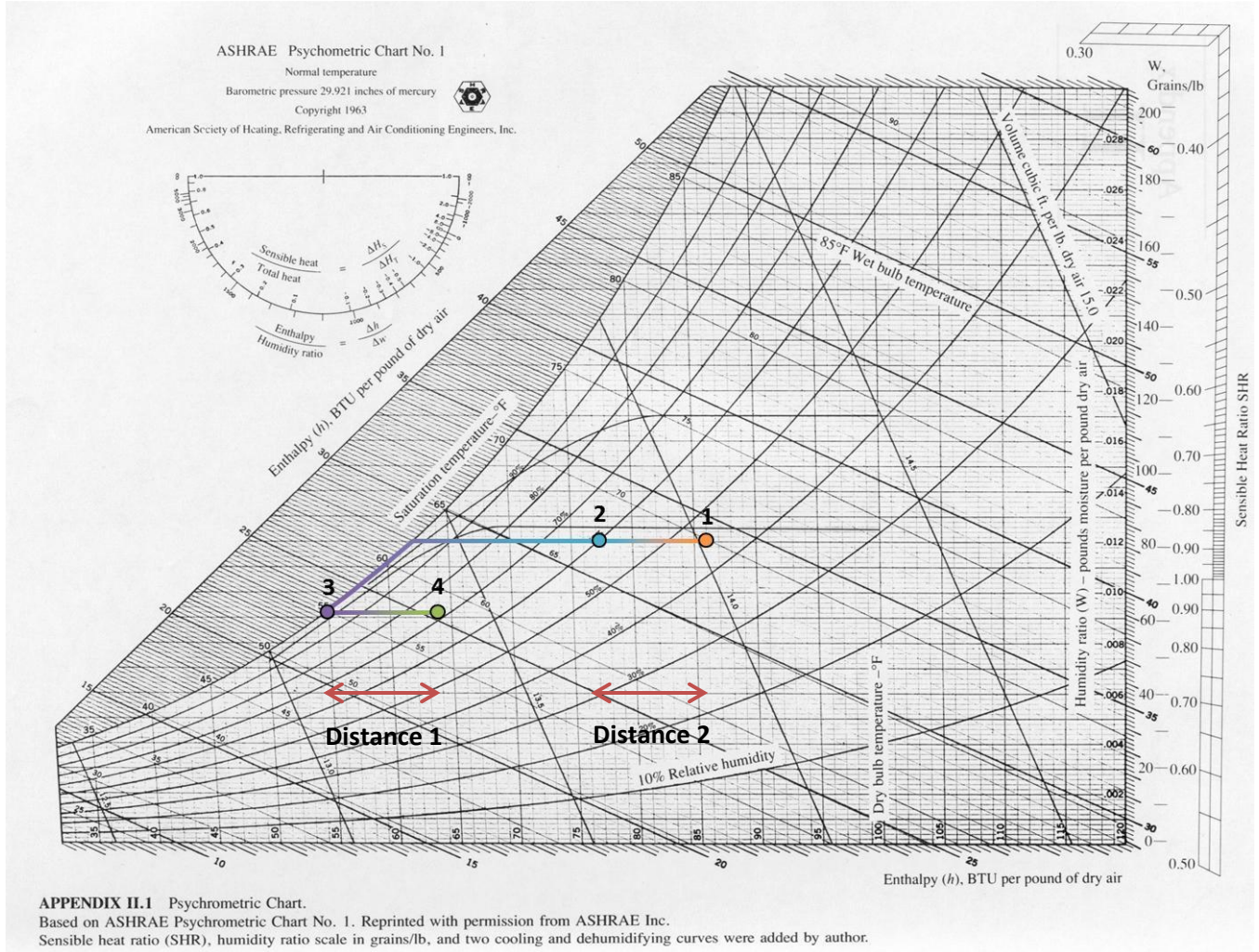
The wrap-around heat pumps works are follows:

- At point 1:** the air enters pre-cooling section of the heat pipe at a high temperature.
- At point 2:** the air leaves the pre-cooling coil, and goes through the cooling coil for dehumidification
- At point 3:** the air enters the reheat coil where it is heated with the pre-cooling exhaust heat
- At point 4:** the air leaves the reheat coil and is ready to be delivered to the space

The table below shows the wet bulb and dry bulb temperature for the air at each point in this process. Matching up the colors, it can be seen that the air to be delivered to the space is **64.1°**. This is the air delivery temperature that is needed to calculate the change in temperature for our load calculation.

GENERAL					WRAP AROUND HEAT PIPES									
UNIT NO.	SERVICE	MODEL NO.	LOCATION	TOTAL UNIT CFM SUPPLY RETURN	MIN OUTSIDE AIR CFM	MIN EXH. AIR CFM	MAX OUTSIDE AIR CFM	MAX EXH. AIR CFM	FACE AREA	VELOCITY FPM	TEMPERATURE			
											HP ENT °F	CC ENT °F	CC LVG °F	HP LVG °F
AHU-1	CLASSROOMS, OFFICES, CORRIDORS AND NON-PUBLIC	WF-RBHPRE60	ROOF	30,000	14,945		30,000		59.5	504	86.5	77.9	55.1	63.7
				27,000	11,945	27,000	70.2	67.6			55.0	58.4		
AHU-2	CLASSROOMS, OFFICES, CORRIDORS AND NON-PUBLIC	WF-RBHPRE62	ROOF	31,700	19,445		31,700		62.3	509	81.7	78.7	54.9	63.9
				27,100	14,845	27,100	70.9	68.2			54.8	58.3		
AHU-3	CLASSROOMS, OFFICES, CORRIDORS AND NON-PUBLIC	WF-RBHPRE54	ROOF	27,000	13,210		27,000		56.7	476	86.5	77.6	55.2	64.1
				24,300	10,510	24,300	70.2	67.5			54.8	58.3		
AHU-4	GYMNASIUM	WF-RBHPRE46	ROOF	20,860	13,360		20,860		51.0	409	83.9	74.1	52.0	61.8
				18,560	11,060	18,560	71.3	68.4			51.9	55.9		
AHU-5	CAFE/KITCHEN	WF-RBHPRE32	ROOF	18,700	11,840		18,700		36.8	508	87.5	78.7	55.1	64.0
				12,500	5,640	12,500	70.9	68.2			54.9	58.4		
AHU-6	AUDITORIUM	WF-RBHPRE19	ROOF	9,600	6,325		9,600		19.1	504	84.0	75.7	53.8	62.1
				9,200	5,925	9,200	70.5	68.0			53.7	57.0		

The diagram below shows the location of each during the wrap-around heat pump cycle on a psychrometric chart. The air is first cooled in the pre-cooling phase. It is then cooled to the dew point line with the cooling coil where the air is dehumidified. Once the air leaves the cooling coil, it is heated to the desired air delivery temperature of **64.1°** with the waste heat from the pre-cooling coil. Notice that distance 1 and distance two are approximately the same length as the air is being reheated with the same amount of heat as was originally extracted.



With all unknowns found, we can calculate the total heat load introduced by the cooling system:

$$Q = 1.08 * CFM * \Delta T (T_{setpoint} - T_{supply})$$

$$Q = 1.08 * (1950) * (72^\circ - 64.1^\circ)$$

$$Q = 1.08 * (1950) * (7.9^\circ)$$

$$Q = 16,637.4 \text{ BTU/hr}$$

Step 3: Calculate skylight heating load

In addition to the cooling system, the skylights add a load on the heating system. During the winter, heat that escapes through the skylights has to be replenished by the fin tube radiators. The mechanical load calculation program TRACE700 was used to calculate the total heating load introduced in the space. Highlighted in the figures below are the total heating load in the space as a result of heat loss through the roof, exterior wall, and façade for the base case of no skylights (on the **left**), and the skylight case (on the **right**). The negative sign in front of the values designates the load as a heating load.

HEATING COIL PEAK				HEATING COIL PEAK			
Mo/Hr: Heating Design OADB: 15				Mo/Hr: Heating Design OADB: 15			
	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)	
Envelope Loads				Envelope Loads			
Skylite Solar	0	0	0.00	Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00	Skylite Cond	0	-4,031	5.63
Roof Cond	0	-3,470	5.03	Roof Cond	0	-3,066	4.28
Glass Solar	0	0	0.00	Glass Solar	0	0	0.00
Glass/Door Cond	-39	-39	0.06	Glass/Door Cond	-39	-39	0.06
Wall Cond	-567	-1,523	2.21	Wall Cond	-567	-1,523	2.13
Partition/Door	0	0	0.00	Partition/Door	0	0	0.00
Floor	0	0	0.00	Floor	0	0	0.00
Adjacent Floor	0	0	0.00	Adjacent Floor	0	0	0.00
Infiltration	-2,938	-2,938	4.26	Infiltration	-2,938	-2,938	4.10
Sub Total ==>	-3,544	-7,971	11.56	Sub Total ==>	-3,544	-11,598	16.20
Internal Loads				Internal Loads			
Lights	0	0	0.00	Lights	0	0	0.00
People	0	0	0.00	People	0	0	0.00
Misc	0	0	0.00	Misc	0	0	0.00
Sub Total ==>	0	0	0.00	Sub Total ==>	0	0	0.00
Ceiling Load	-764	0	0.00	Ceiling Load	-764	0	0.00
Ventilation Load	0	0	0.00	Ventilation Load	0	0	0.00
Adj Air Trans Heat	0	0	0	Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00	Ov/Undr Sizing	0	0	0.00
Exhaust Heat		689	-1.00	Exhaust Heat		945	-1.32
OA Preheat Diff.		-58,584	84.96	OA Preheat Diff.		-58,584	81.83
RA Preheat Diff.		0	0.00	RA Preheat Diff.		0	0.00
Additional Reheat		-6,061	8.79	Additional Reheat		-8,698	12.15
System Plenum Heat		2,975	-4.31	System Plenum Heat		6,345	-8.86
Underflr Sup Ht Pkup		0	0.00	Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00	Supply Air Leakage		0	0.00
Grand Total ==>	-4,308	-68,953	100.00	Grand Total ==>	-4,308	-71,589	100.00

To calculate the load introduced by the skylights, the following formula is applied:

$$\text{Skylight heating load} = (\text{Skylight scenario heating load}) - (\text{Base case heating load})$$

$$\text{Skylight heating load} = (11,598 \text{ BTUs/hr}) - (7,971 \text{ BTUs/hr})$$

$$\text{Skylight heating load} = 3,627 \text{ BTUs/hr}$$

Step 4: Determine if existing fin tubes are sufficient for new load

Now that all load calculations have been performed a comparison can be made. The load capacity comparison calculations are as follows:

Base Case:

- Total load = (16,637.40 + 7,971.00) = 24,608.40 BTUs/hr
- % Under capacity = $[(29,290.00 - 24,608.40) / (29,290.00)] = 16.0 \%$

Skylight Case:

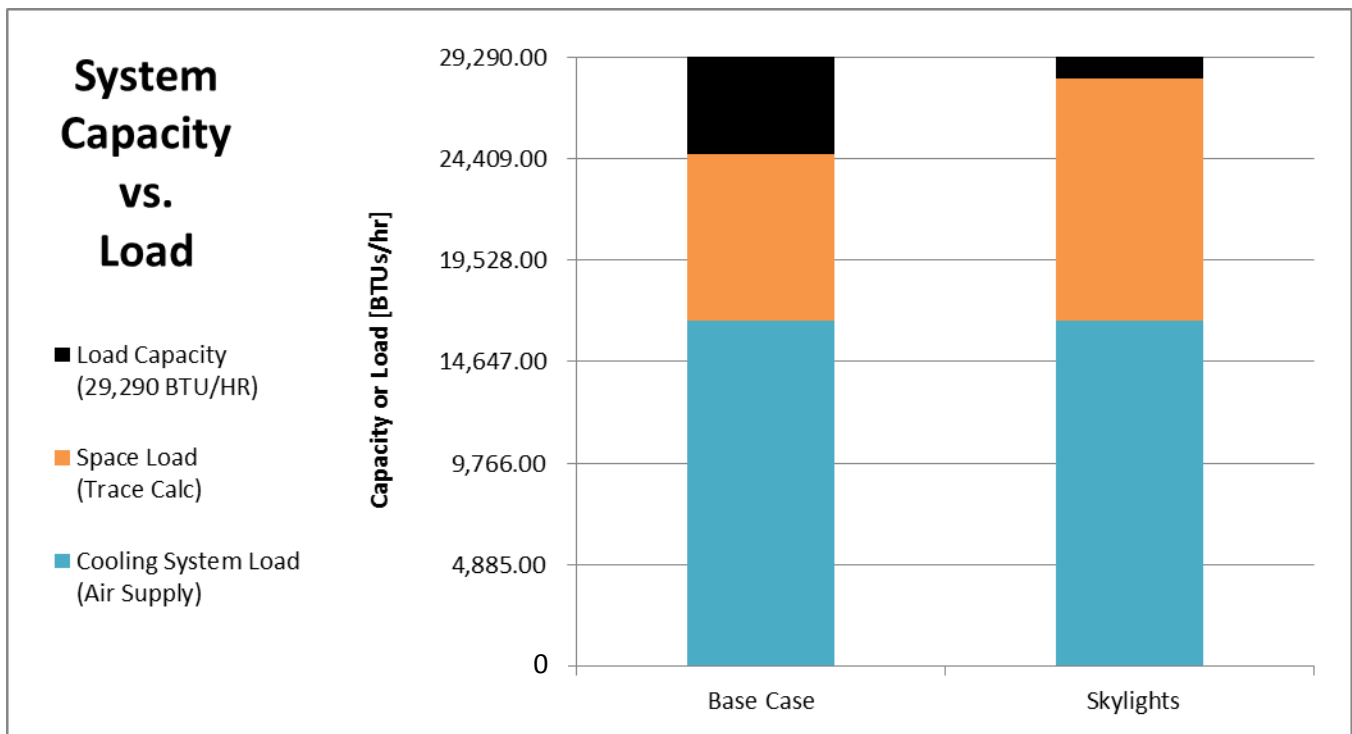
- Total load = (16,637.40 + 11,598.00) = 28,235.40 BTUs/hr
- % Under capacity = $[(29,290.00 - 28,235.40) / (29,290.00)] = 3.6 \%$

The table below shows the total load for each space compared to the capacity of the system, which is 29,290.00. The load capacity calculations are as follows:

Scenario Comparison		
	Base	Skylights
System Capacity	29,290.00	29,290.00
Space Load	16,637.40	16,637.40
Cooling System	7,971.00	11,598.00
% under Capacity	16.0%	3.6%

The graph below shows a graphical representation of the system capacity of the comparison in the table to the left. The height of the bars is equal to the total load capacity of the heating system, and as such, the **black** bar represents how system capacity is available in excess of the heating load.

In conclusion, as the total heating load in the skylighting scenario is still **3.6%** below the capacity of the system, **NO ADDITION FIN TUBE RADIATORS NEED TO BE ADDED INTO THE SPACE.**



Cooling | Mechanical Duct work

The HS Art Room is cooled via the overhead duct system. With the addition of the skylights, additional load will be put onto the mechanical cooling system. The goal is thus to determine if the existing ductwork are sufficiently sized to handle the additional (cooling) load resulting from the introduction of the skylight system. The following steps to determine this are as follows:

- Step 1: Calculate total space heating **capacity**
- Step 2: Determine the **occupant** total sensible load
- Step 3: Determine the total **equipment** cooling load
- Step 4: Calculate total **heat gain** through room surfaces
- Step 5: **Calculate CFM** needed and compare

Step 1: Calculate total space heating capacity

The space has a total of 6 diffusers each supplying 325 CFM. Refer to Step 2 under Heating | Fin Tube Radiator for diffuser locations. The total air supply to the space is calculated as follows:

$$\text{Total air flow to space} = (325 \text{ CFM/Diffuser}) * (6 \text{ Diffusers}) = \mathbf{1950 \text{ CFM}_{\text{supply}}}$$

Step 2: Determine the occupant total sensible

$$Q_{\text{sensible}} = (36 \text{ People}) * \left(\frac{250 \text{ BTU/hr}}{\text{Person}} \right)$$

$$Q_{\text{sensible}} = \mathbf{9,000 \text{ BTU/hr}}$$

Step 3: Determine the total equipment cooling load

$$Q_{\text{Equipment}} = (Q_{\text{Lighting}} + Q_{\text{misc. equipment}}) * (\text{Room Area})$$

$$Q_{\text{Equipment}} = \left(1.24 \frac{\text{W}}{\text{ft}^2} + 1.0 \frac{\text{W}}{\text{ft}^2} \right) * (1260 \text{ ft}^2)$$

$$Q_{\text{Equipment}} = 2822.4 \text{ Watts}$$

$$Q_{\text{Equipment}} = (2822.4 \text{ Watts}) * \left(\frac{3.412 \text{ BTU/hr}}{1 \text{ Watt}} \right)$$

$$Q_{\text{Equipment}} = \mathbf{9630 \text{ BTU/hr}}$$

Step 4: Calculate total heat gain through room surfaces

Not that the total load from the occupants and the space are known, the total heat gain through the surfaces in the room can be calculated. To calculate the conductive heat gain through the room surfaces, the following equation is used:

$$\frac{Q}{t} = \frac{kA(T_{hot} - T_{cold})}{d}$$

The table below shows the application of this conductive heat transfer equation to all surfaces for which heat gain will occur. It is assumed that interior walls that are shared with another interior space will have no net heat transfer as both spaces will have (approximately) the same room temperature. As such, the only room surfaces considered are those that are shared with the exterior. These surfaces are as follows: the roof, exterior walls, skylights, and façade (glazing).

Total gain loss through room surfaces							
Surface	u [BTU/hr*Ft ² *F]	d [Ft]	k [BTU/hr*Ft*F]	A [Ft ²]	Thot [°F]	Tcold [°F]	q [BTU/hr]
Roof	0.05	1.5	0.075	1113	89.5	75	806.925
Wall	0.056	1.5	0.084	173.8	89.5	75	141.1256
Skylight	0.495	0.08333	0.04124835	147	89.5	75	1055.093
Façade	0.3	0.2	0.06	415	89.5	75	1805.25
Total:							3808.393

From the calculation in the previous table, using the conductive heat transfer equation, the total heat gain through the room surfaces is computed. This heat transfer totals **3,808.39 BTUs/hr**.

Step 5: Calculate CFM needed and compare

$$Q_{net} = \Sigma Q = \Sigma Q_{supply} - \Sigma Q_{load}$$

$$Q_{net} = (q_{capacity}) - (q_{occupant} + q_{misc\ equipment} + q_{cond\ room\ surfaces})$$

$$Q_{net} = (22,955) \text{ BTU/hr} - (13,000 + 9630 + 3,808) \text{ BTU/hr} = -3,483 \text{ BTUs/hr}$$

Q_{net} , as visible in the previous calculation, is **-3,483 BTUs/hr**. The fact that it is negative means that the capacity of the cooling system is not sufficient to handle the load of the space with the skylight included. As the system is not capable of cooling the full load in the space, the ductwork needs to be upsized. The next step is to determine the additional CFM needed to meet the load requirements of the space.

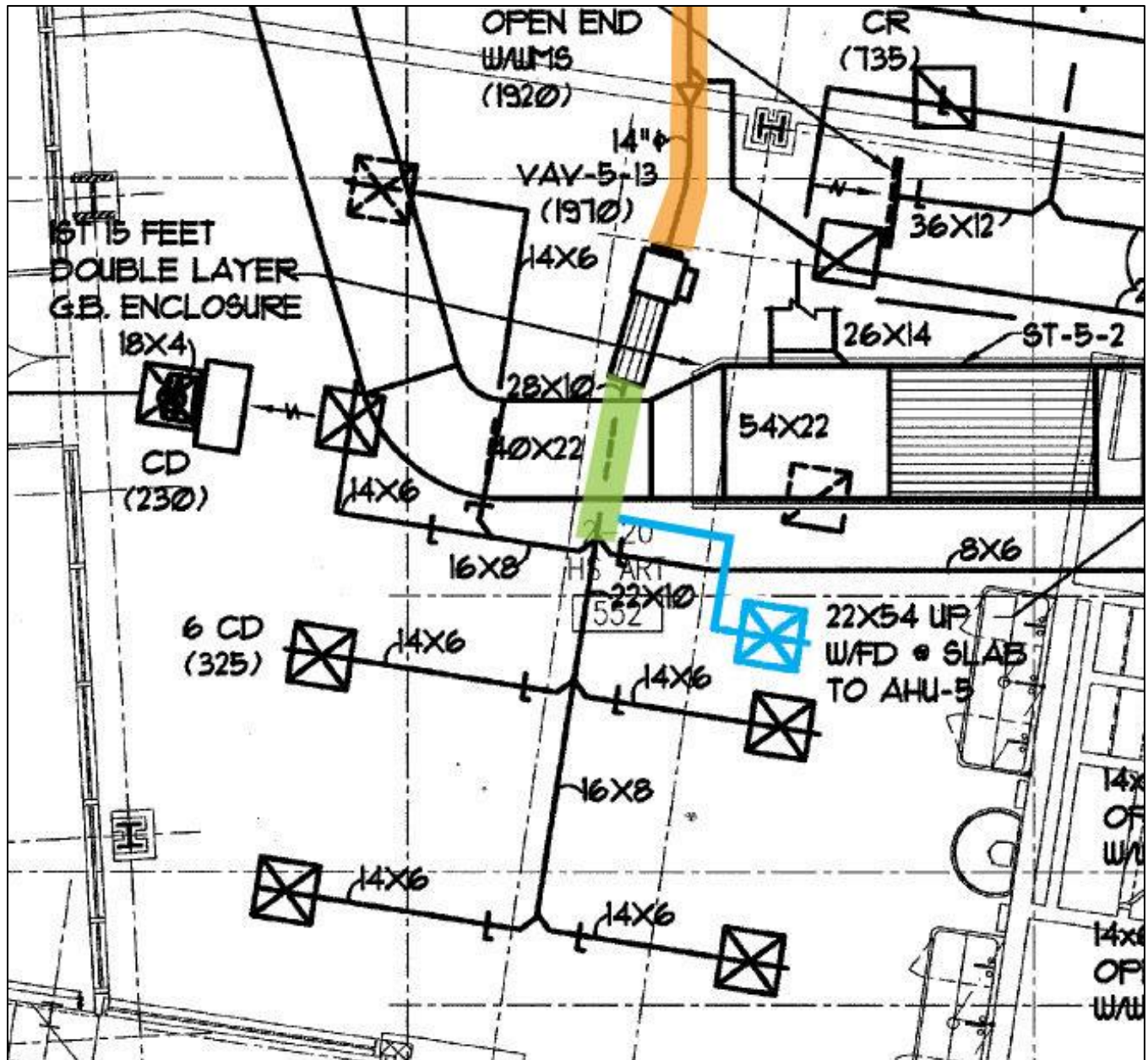
$$Q = 1.08 * CFM * \Delta T$$

$$CFM = \frac{Q}{1.08 * (T_{set\ point} - T_{supply})}$$

$$CFM = \frac{3,483 \text{ BTUs/hr}}{1.08 * (75 - 64.1)^\circ\text{F}} = 296 \text{ CFM}$$

Sizing Comparison		
Color	Existing	Resized
	14" ϕ	16" ϕ
	28"x10"	30"x10"
	N/A	10"x10"

The table to the left and the plan below are intended to graphically represent the ductwork and piping that has been affected by the additional load introduced in the space. Because of the extra CFM needed, an additional diffuser has been added to the space, as shown in blue. The duct is connected to the main supply duct (shown in green) as to avoid resizing all other ductwork downstream. The main supply pipe, the 14" diameter pipe shown in orange, has to be upsized to account for the additional CFM needed in the space. From 14 inches in diameter, it is upsized to 16 inches. Although the changes are minor in comparison to the magnitude of the original duct sizes, they are changes that must be made to meet the load. All sizes were calculated using a ductulator.



Conclusion

Adequacy calculations for both the heating and cooling systems have been presented. It has been shown that the existing heating system, which utilizes fin tube radiators, is sufficiently sized to handle the additional load introduced by the skylighting system. With the additional load from the skylights, the system is still oversized by **3.6%** with a remaining (available) capacity of **1,055 BTUs/hr**. No upsizing of the fin tube radiators is needed, and thus there are no (heating system) material cost implications with the introduction of the skylights. However, there will be cost increases in energy use as the system will be combatting a higher load than previously, which is inherent with any load increase.

The cooling system on the other hand, has been shown to be inadequate to handle the additional load associated with the introduction of the skylights. The cooling system, which is predominantly the overhead ductwork, provides too few CFM to the space. As such, appropriate resizing has been done. The tables below show the cost implications of the mechanical ductwork resizing. The existing ductwork is estimated to have cost **\$104.05**. The new ductwork, which includes the change from 14" diameter circular ductwork to 16" diameter and change from 28x10 duct to 30x10, is estimated to cost **\$126.55**. The new system, due to an increase in supply CFM needed, requires an additional 10"x10" diffuser. The cost of a 10"x10" duct with appropriate supply duct is estimated to cost **\$224.00**.

The total cost of increasing the ductwork is as follows:

$$\begin{aligned}
 \text{Total cost (\$)} &= \text{New System Cost (\$)} - \text{Existing System Cost (\$)} \\
 \text{Total cost (\$)} &= (\$126.55 + \$224.00) - (\$104.05) \\
 \text{Total cost (\$)} &= \mathbf{\$246.50}
 \end{aligned}$$

Mechanical Ductwork resizing cost				
Category	Existing		New	
Baseline Duct Size	14"φ	28x10	16"φ	30x10
Total [lf]	15	10	15	10
Weight [lb/lf]		9.18		9.65
Total Weight [lb]		91.8		96.5
RS Means		0100		0100
Material (\$/Lb)		3.58		3.58
Round Material [\$/LF]	4.55		6.05	
Total Material /LF or LB	4.55	3.58	6.05	3.58
Total Cost	68.25	35.8	90.75	35.8
Total:	104.05		126.55	
Cost Difference:	\$22.50			

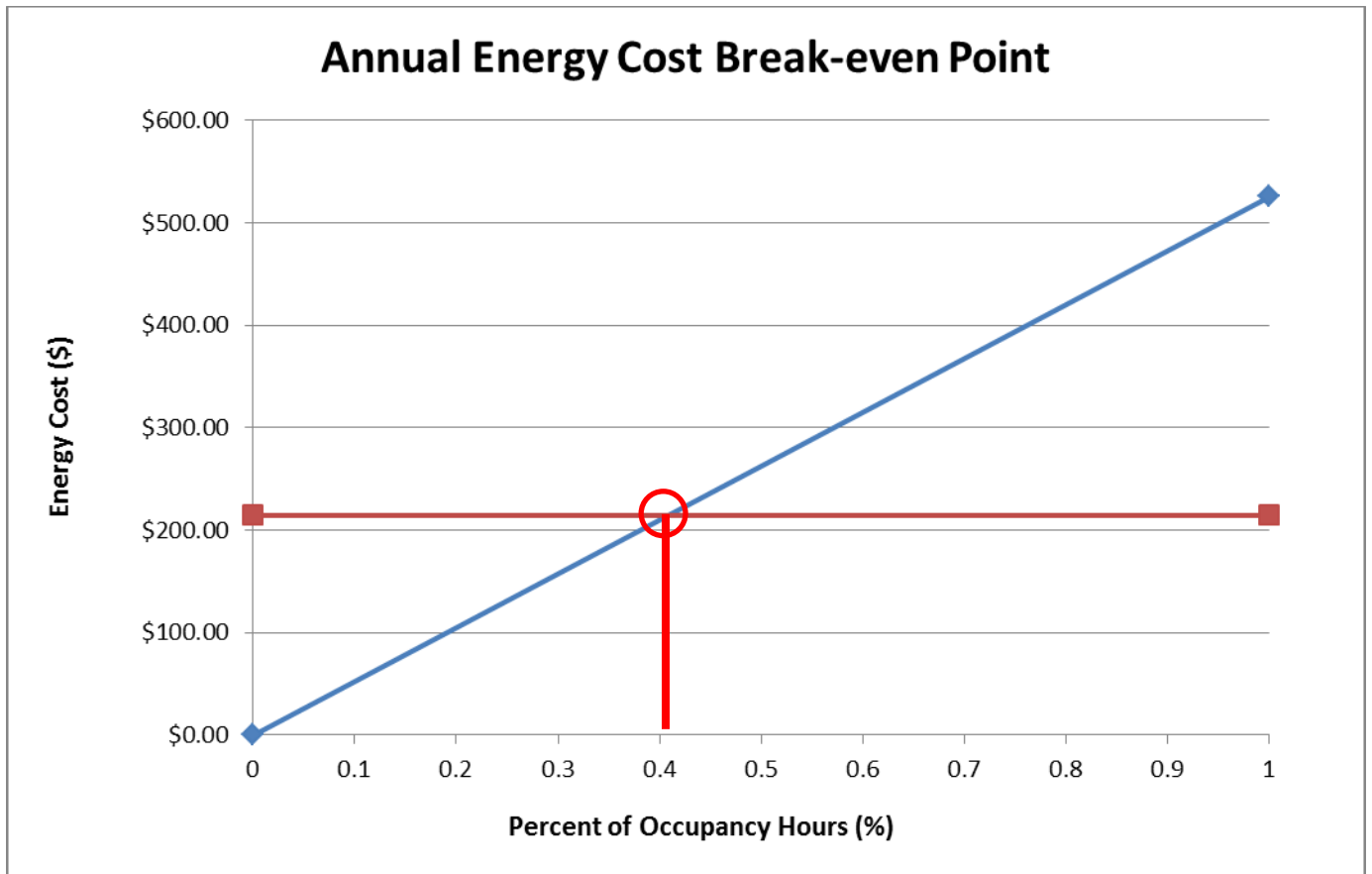
10"x10" Diffuser	
Material	\$ 162.00
Labor	\$ 30.00
Overhead	\$ 32.00
Total:	\$ 224.00

Note: All cost data was taken from RS Means 2010.

In addition to material cost implication of upsizing the ductwork, there is going to be operating energy cost implications due to the introduction of the skylights. During the summer, when the cooling system is in effect, heat gain through the skylights is going to increase the load on the system. In the winter, when the heating system is in effect, solar heat gain through the skylights will reduce the load on the heating system. The table below presents the cost associated with each of these scenarios. The total net operating energy cost of the skylight system is **-\$214.32**.

Cost of heating and Cooling due to Skylighting load								
Load Type	% Occupancy Hours	Occupancy Hours	BTU/hr	W	kW	kWh	\$/kWh	\$
Cooling	0.4	2727	-5400	-1578.95	-1.58	-1722	0.2	-344.46
Heating	0.6	2727	4533.75	1325.658	1.33	2169	0.2	130.14
Savings:								-214.32

Plotting a line of total cost implications of the skylights on the lighting system energy cost plot (presented in the MAE breadth section) we see that if the lighting system is switched off approximately 40% of the occupancy hours, the lighting system will save as much energy costs as the mechanical energy costs. This is the break-even point. For every occupancy hour over this that the lighting is switched off, net energy savings are incurred.



Breadth three | BIM

Introduction

The previous two depths, which were based upon the introduction of skylights into the High School Art Room, assume that the skylights introduced into the space are free from obstruction. Although this is a rational assumption for the simplification of analysis, it is the ideal case and is likely without consideration of the systems in the ceiling space. The main goal of this depth is thus to analyze the existing coordination of the systems in the ceiling space of the High School Art Room, and to redesign the ceiling space to accommodate the skylighting system.

Most of the deliverables for a coordination analysis would typically include renderings, sections, and conflict reports demonstrating that no conflicts or crashes exist within the ceiling space redesign. However, the coordination analysis will also consider the effects of the ceiling space layout on the skylight layout. This consideration will facilitate two calculations:

1. What percentage are the skylights covered for the original design as opposed to the new design?
2. What change in illuminance does the change in skylight coverage area amount to?

The systems included in the coordination analysis are as follows:

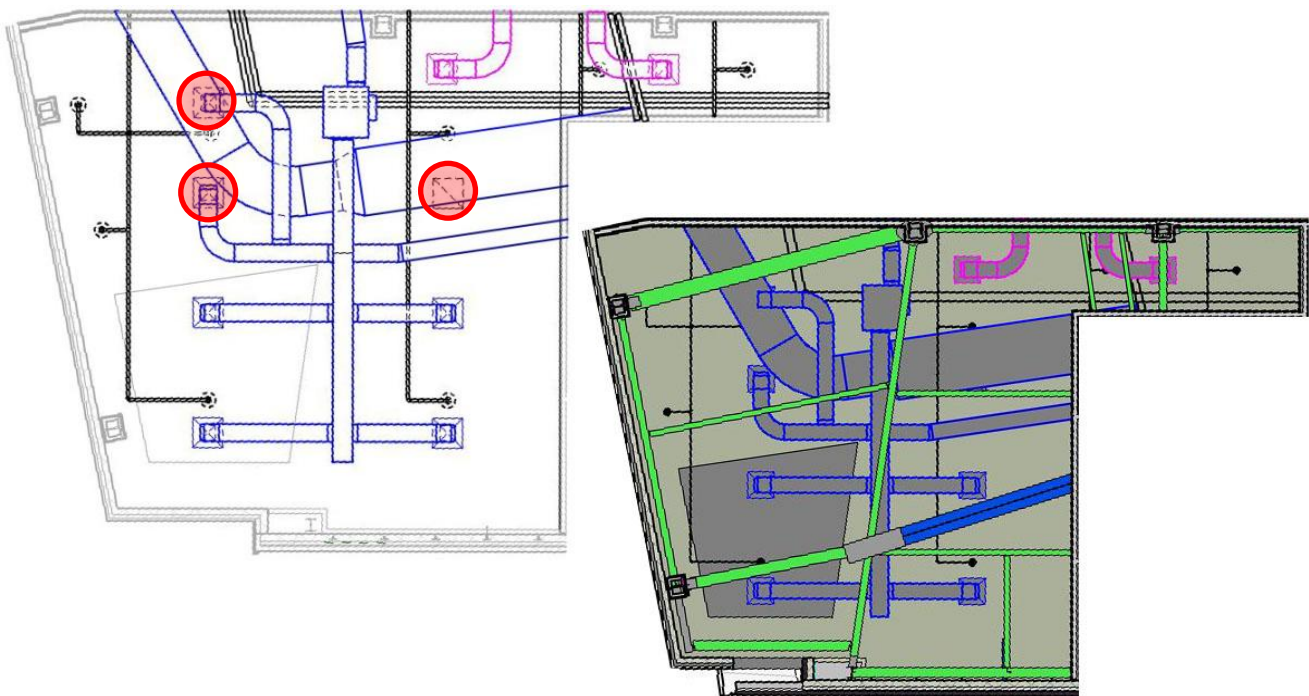
- Mechanical System (including supply and return duct)
- Sprinkler System (including supply piping and sprinkler heads)
- Plumbing (Include Hot and Cold water supply and return)
- Lighting (Suspended linear fluorescent and suspended CFL pendants)
- **Wire and conduit were NOT modeled**

The content of this breadth is thus organized as follows:

- **Step 1:** Model existing ceiling layout
- **Step 2:** Redesign ceiling layout to accommodate skylights
- **Step 3:** Compare two scenarios, performing appropriate calculations
- **Step 4:** Prove ceiling space is organized and conflict-free
 - Sections / 3d Interior Views
 - Renderings

Step 1: Model existing ceiling layout

The first step in this breadth is modeling the existing High School Art Room ceiling space to analyze the conflicts and clashes. The existing ceiling space layout, which was taken from the drawings provided to me by SKANSKA, were only represented in 2D. It was the goal of this step to take the 2D plans, and create a 3D BIM model to analyze the clashes of the system that may have not been caught originally in the 2D plans. A 3D BIM model of the space was created in REVIT MEP 2012, and the existing systems modeled. The two figures below represent the existing mechanical system. The left image represents the plan layout of the ceiling space, where the right image shows a section cut of the 3D model. The image on the right shows the layout of the ceiling space system below the structural members. The plan layout on the left does not show the structural system.

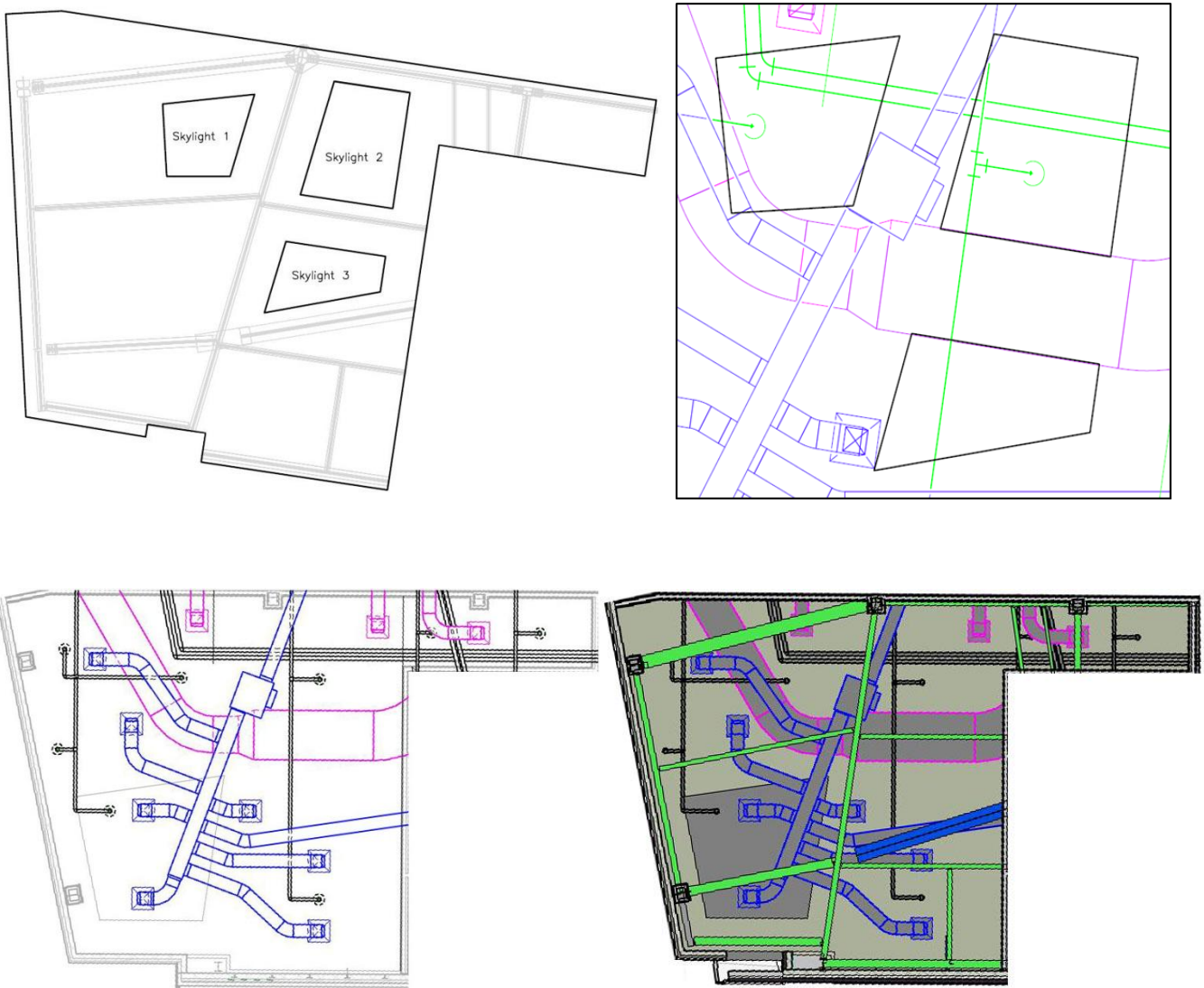


Although best effort was given to model the existing system without conflicts, it proved difficult to do so. The previous plan layout of the ceiling space highlights (in **red**) the area which conflicts could not be avoided—staying true to the existing design that is. A few diffusers conflicted with the air return duct, and a return grille, located directly under the return duct, was unable to be fed directly to the return due to lack of space above it.

Step 2: Redesign ceiling layout to accommodate skylights

After analyzing the existing layout, the system must next be coordinated as to minimally affect the skylighting layout. The first image below shows the skylight layout of the room as proposed in the MAE breadth section. The second image (on the right of the first row) shows how the skylights sit in relation to the systems in the ceiling. As you can see, the supply and return ducts have been rotated and moved so they do not obstruct the skylights. A direct comparison will be made in the next step.

The left image in the second row represents the plan layout of the redesigned ceiling space, where the right image shows a section cut of the 3D model. The image on the right shows the layout of the ceiling space system below the structural members. The plan layout on the left does not show the structural system.



Step 3: Compare two scenarios

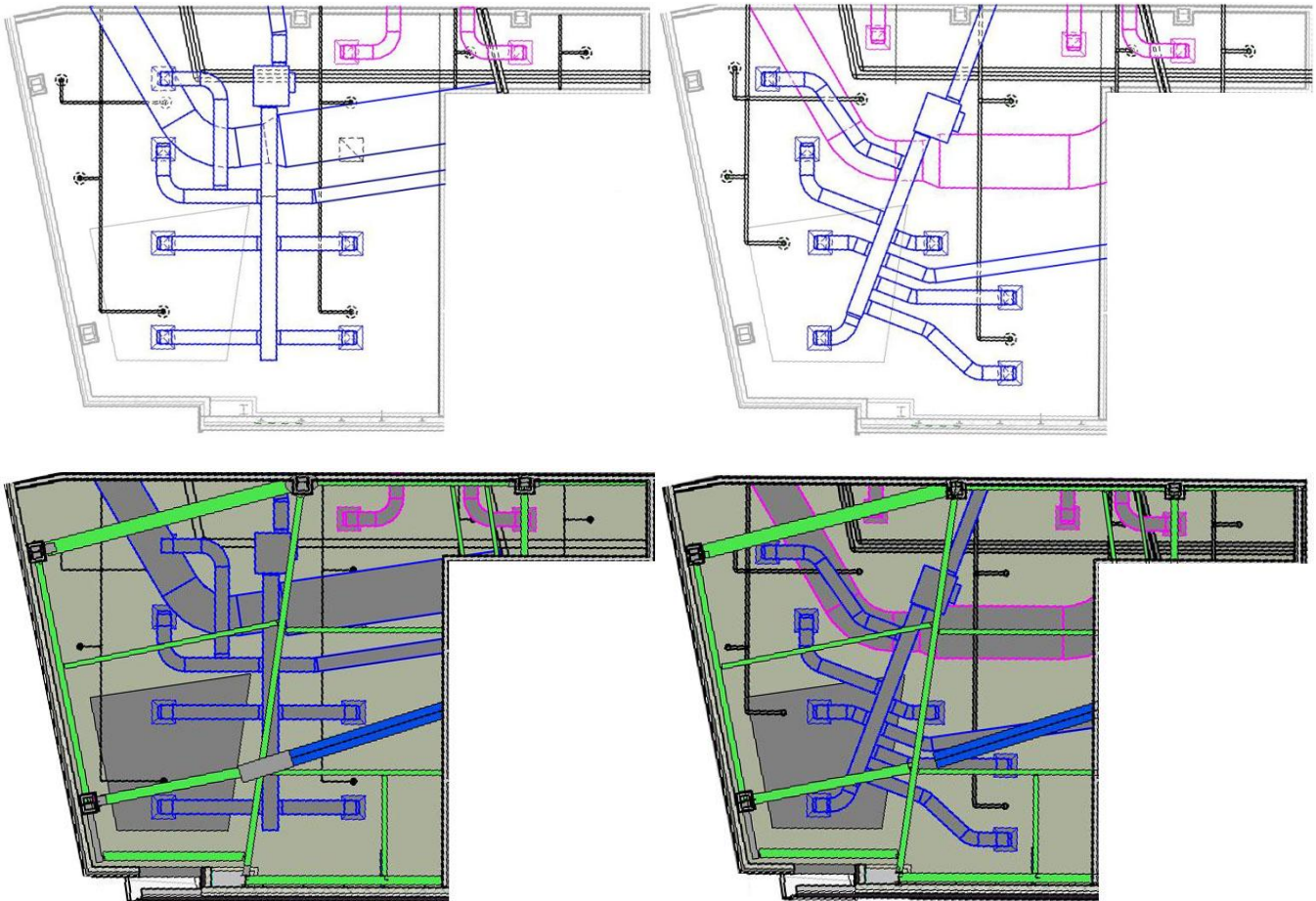
Now that the existing system has been redesigned and coordinated as best possible, it is time to analyze them side-by-side. Additionally, two calculations will be performed so that a quantitative comparison may be made between the two. These two calculations are:

1. What percentage are the skylights covered for the original design as opposed to the new design?
2. What change in illuminance does the change in skylight coverage area amount to?

The images below show a visual comparison of the existing layout versus the proposed layout. The images in the left column represent the existing design as taken from the buildings' drawings. The images to the right are for that of the redesigned system. The top images represent the plan layout of the ceiling space, where the top images show a section cut of the 3D model. The bottom images show the layout of the ceiling space system below the structural members. The plan layouts on top do not show the structural system.

EXISTING ceiling space layout

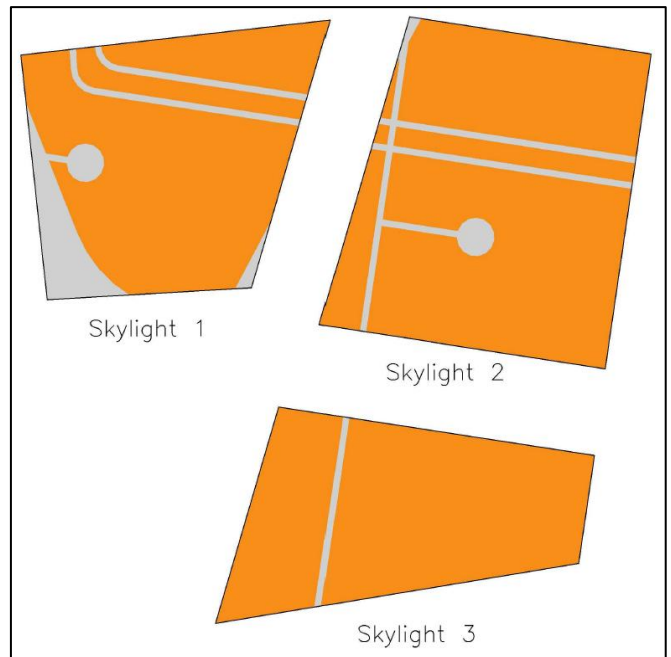
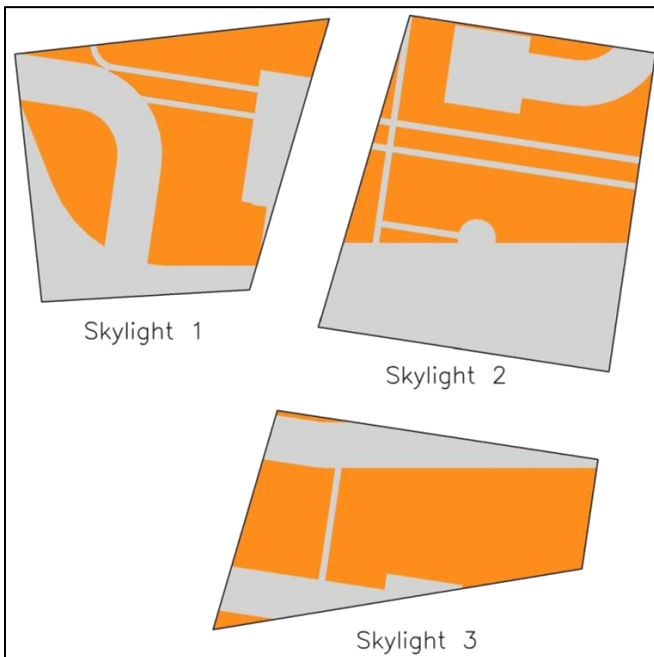
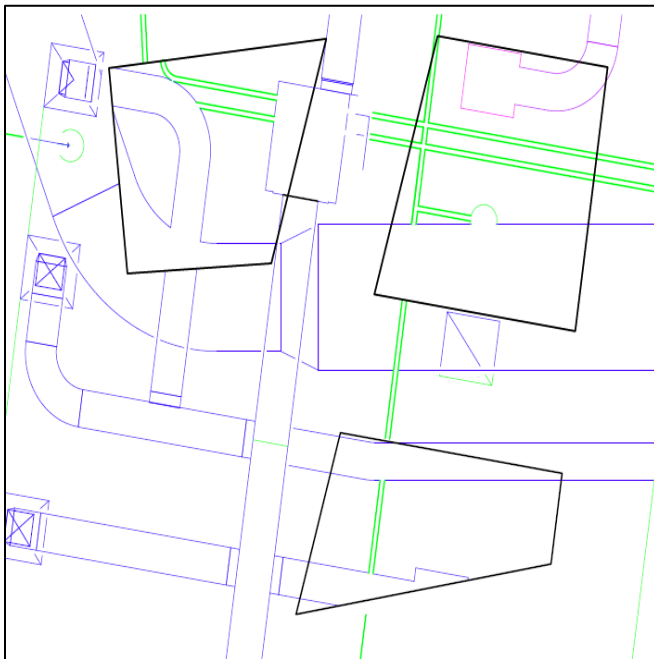
PROPOSED ceiling space layout



Overlaying the skylight layout on the layout of the ceiling space equipment, a side-by-side comparison can be made of how covered the skylights are. The figures on the left represent the existing ceiling layout, whereas the figures to the right show the proposed, or redesigned system. The top images show the overlap of the skylights and MEP equipment in wireframe view. This enables a quick determination of the equipment that runs through the skylight. The bottom images show the coverage areas of the skylights, via two colors. **Orange** shows the portion of the skylight that is unobstructed. **Grey** represents the area that is occupied by some portion of equipment.

EXISTING ceiling space layout

PROPOSED ceiling space layout



Using the previous figures, the total percentage of area that is covered can be calculated. The figures below show the tabular calculation for each individual skylight, under both the existing and redesigned conditions. The skylights with the existing ceiling coordination design are obstructed **46.47%** (by area). Under the new design, the skylight obstruction area was reduced to **9.10%**.

The total reduction in area coverage = (Existing Design coverage) – (Proposed Design Coverage)

The total reduction in area coverage = (46.47%) – (9.10%) = 37.57%

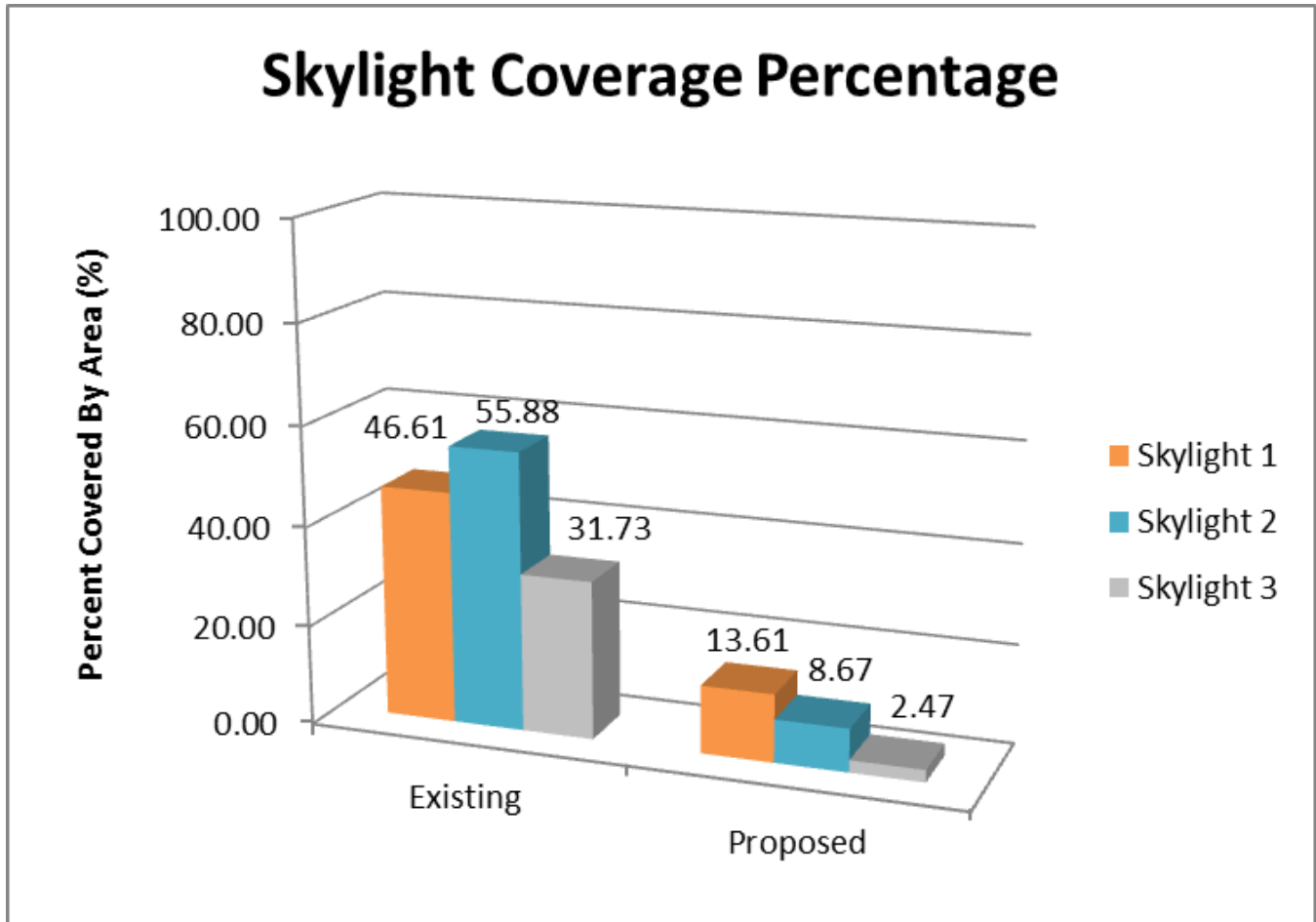
Covered Skylight Area: Existing Design						
	Existing Design					
	Skylight 1		Skylight 2		Skylight 3	
Area	Open	Covered	Open	Covered	Open	Covered
	0.489	-	9.57	-	0.205	-
	6.258	-	0.267	-	5.92	-
	1.697	-	0.169	-	19.21	-
	10.08	-	3.24	-	0.381	-
	5.42	-	1.38	-	-	11.95
	-	20.9	10.6	-	-	-
	-	-	0.527	-	-	-
	-	-	-	7.8	-	-
	-	-	-	24.82	-	-

Total Area:	23.944	20.9	25.753	32.62	25.716	11.95
% Covered	46.61		55.88		31.73	
% Covered	46.47%					

Covered Skylight Area: Proposed Design						
	Proposed Design					
	Skylight 1		Skylight 2		Skylight 3	
Area	Open	Covered	Open	Covered	Open	Covered
	6.83	0.99	0.254	-	11.22	-
	3.34	1.15	17.29	-	21.61	-
	37.23	4.95	0.169	-	-	0.83
	-	0.38	3.24	-	-	-
	-	-	3.45	-	-	-
	-	-	26.17	-	-	-
	-	-	-	4.8	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-

Total Area:	47.4	7.47	50.573	4.8	32.83	0.83
% Covered	13.61		8.67		2.47	
% Covered	9.10%					

The graph below shows a visual representation of the coverage area percentages presented in the tables on the previous page. Comparing the existing and proposed scenario, you can see the reduction in area per skylight.



As calculated on the previous page, approximately 36% of the skylight area has been opened up with the redesign of the systems in the ceiling space. The next useful calculation will be to translate the skylight coverage area to illuminance values. The table below does just this. With the existing system, an average illuminance of **14.55 FC** was achieved in the space. With the new system, an average illuminance of **20.31 FC** was achieved. This equates to an approximate increase in illuminance of **40%**.

Illuminance Comparison			
Category	Existing	Proposed	% Better
Average	14.55	20.31	39.6%
Avg/Min	29.1	11.28	61.2%
Max/Min	77.8	30.17	61.2%

This calculation was performed under an overcast sky, at noon, on March 21st, 2012.

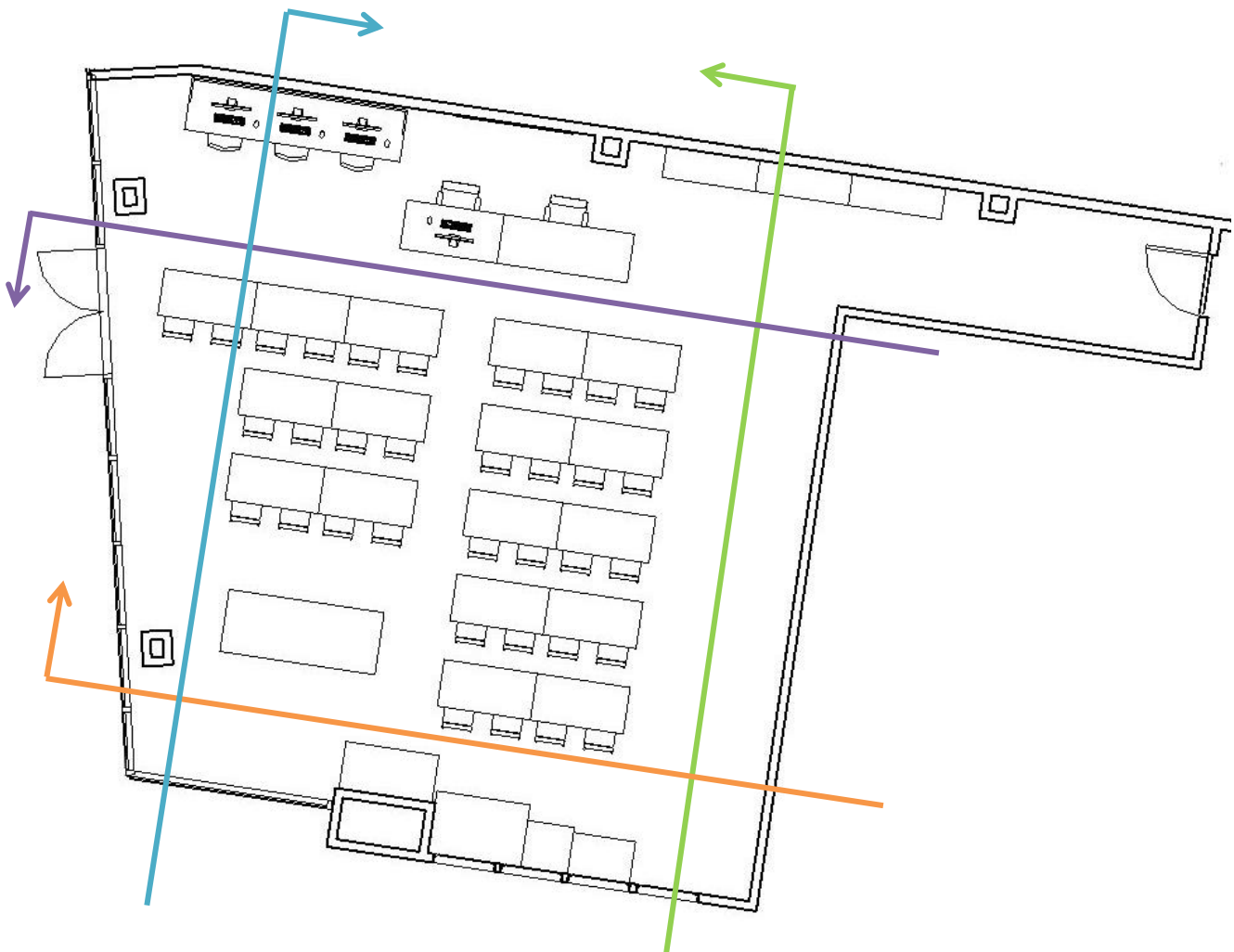
Step 4: Prove ceiling space is organized and conflict-free

This section is dedicated to showing views and section cuts of the space as to provide evidence of a clash-free design. This section is split into two sections: the first includes sections and 3d cuts of the space; the second consists entirely of interior renderings of the space.

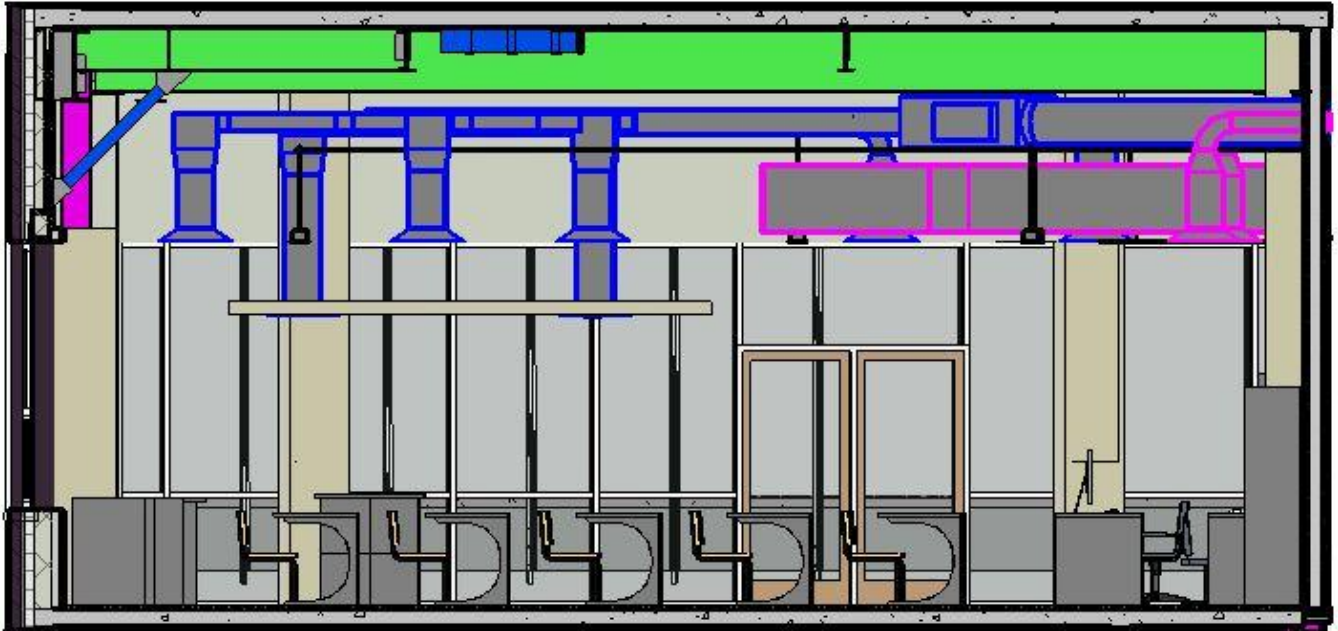
Sections

This portion of step 4 is dedicated to showing section cuts (both 2d and 3d) of the space to help provide a better understanding of the configuration of the systems in the ceiling space of the High School Art room. The plan below shows the layout of the art room, with 4 separate (colored) lines across it. These colored lines represent the section plane for the four sections on the following pages. The arrow represents the viewing direction. The colors are assigned to the following sections:

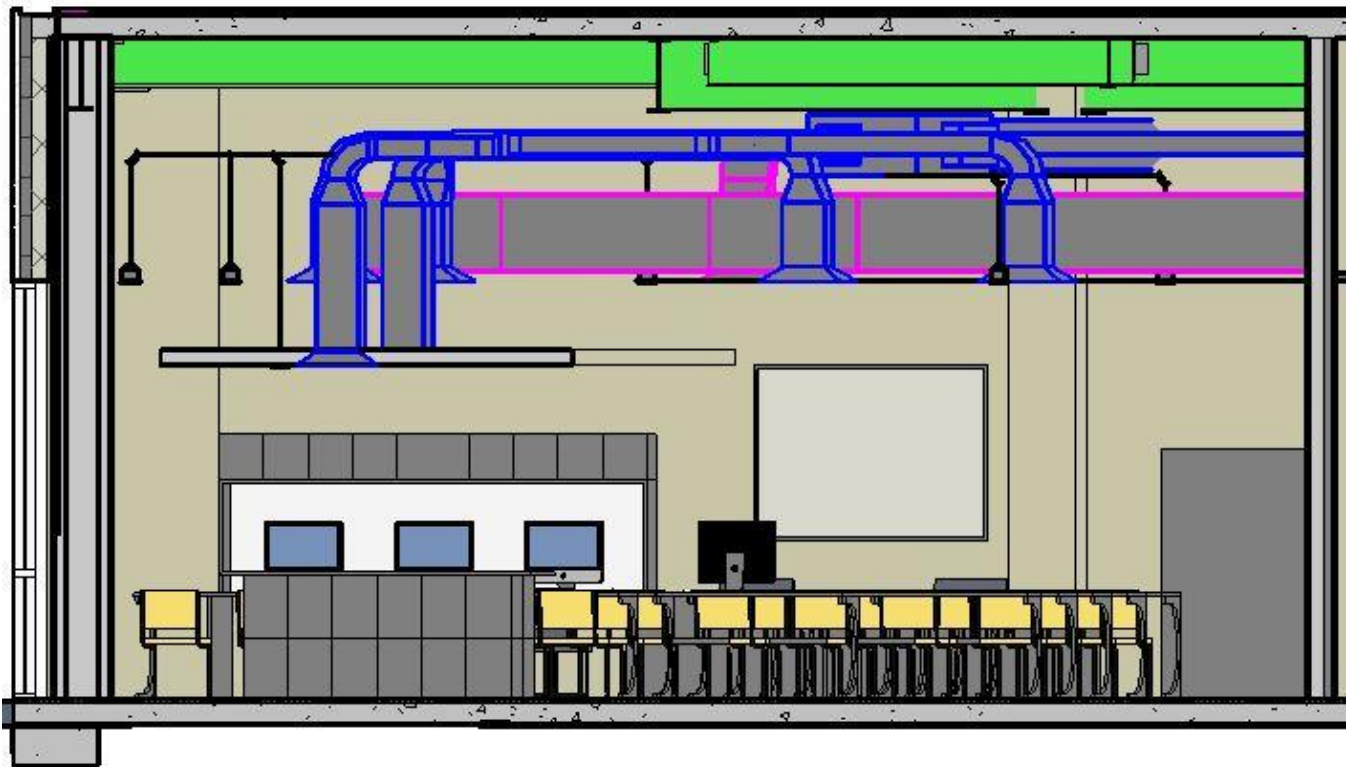
- Section 1: GREEN
- Section 2: ORANGE
- Section 3: PURPLE
- Section 4: BLUE



Section 1:



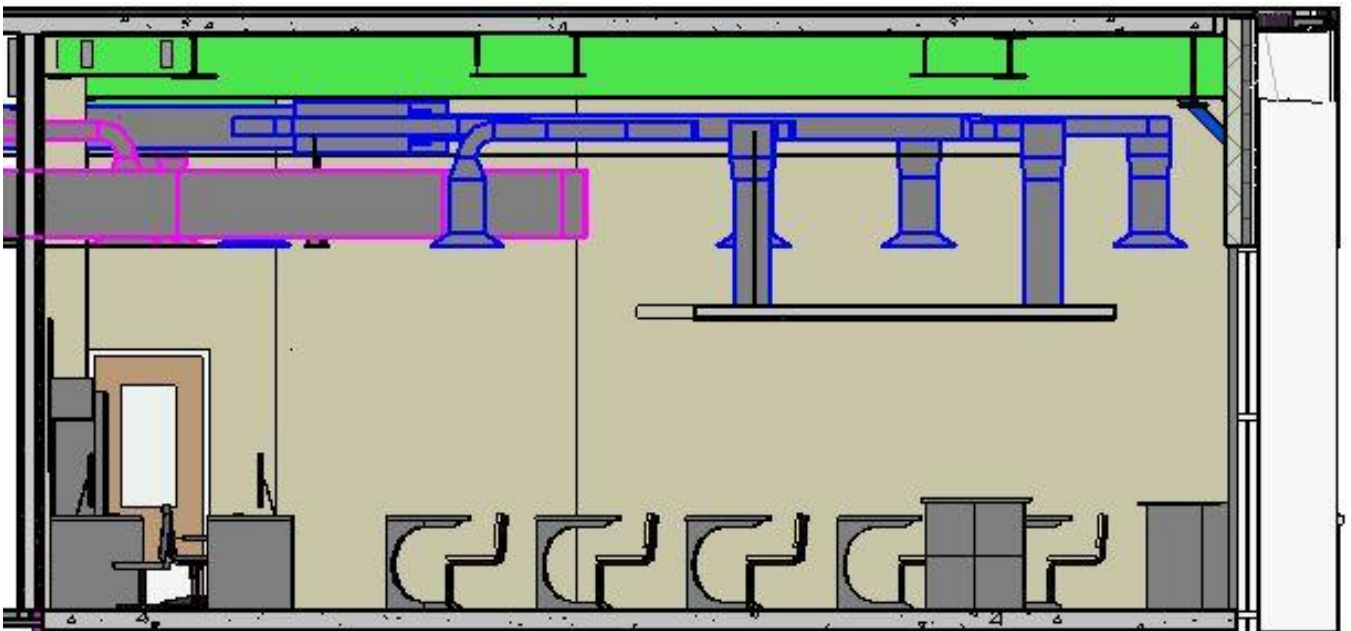
Section 2:



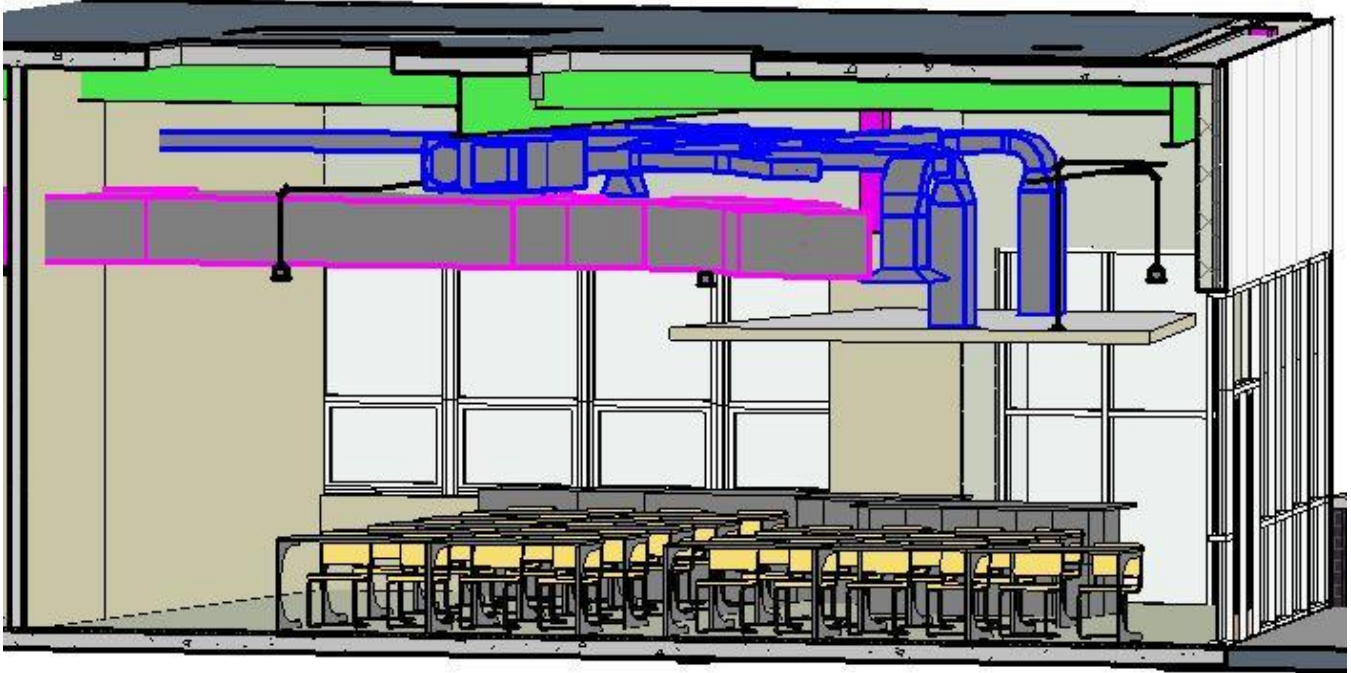
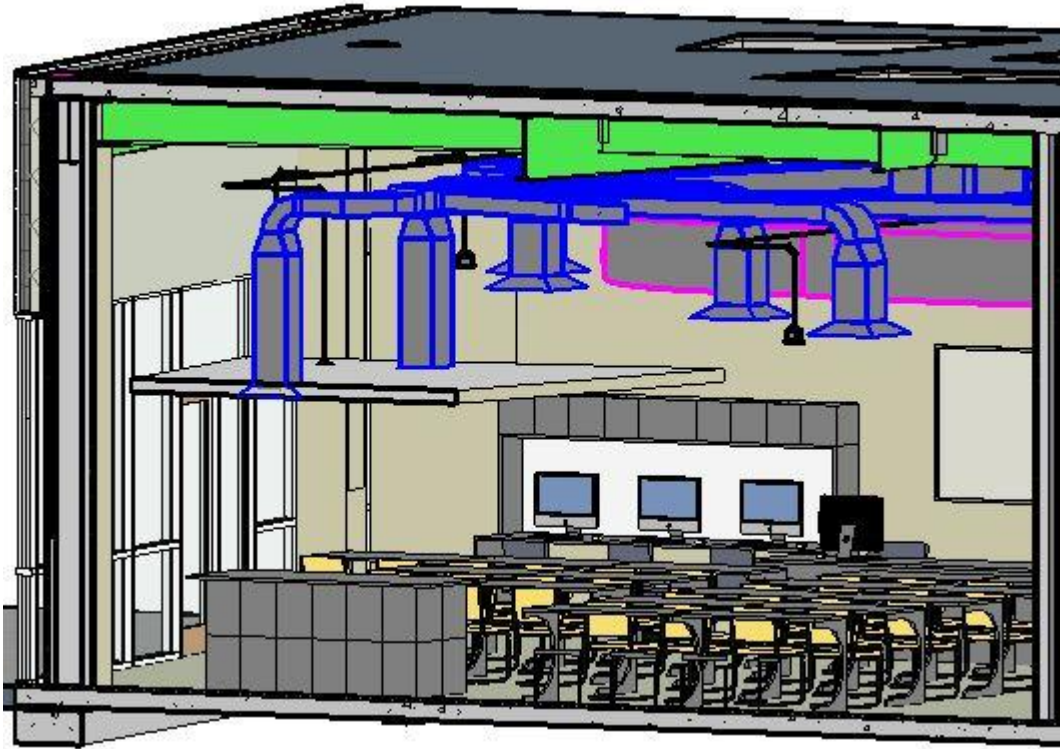
Section 3:



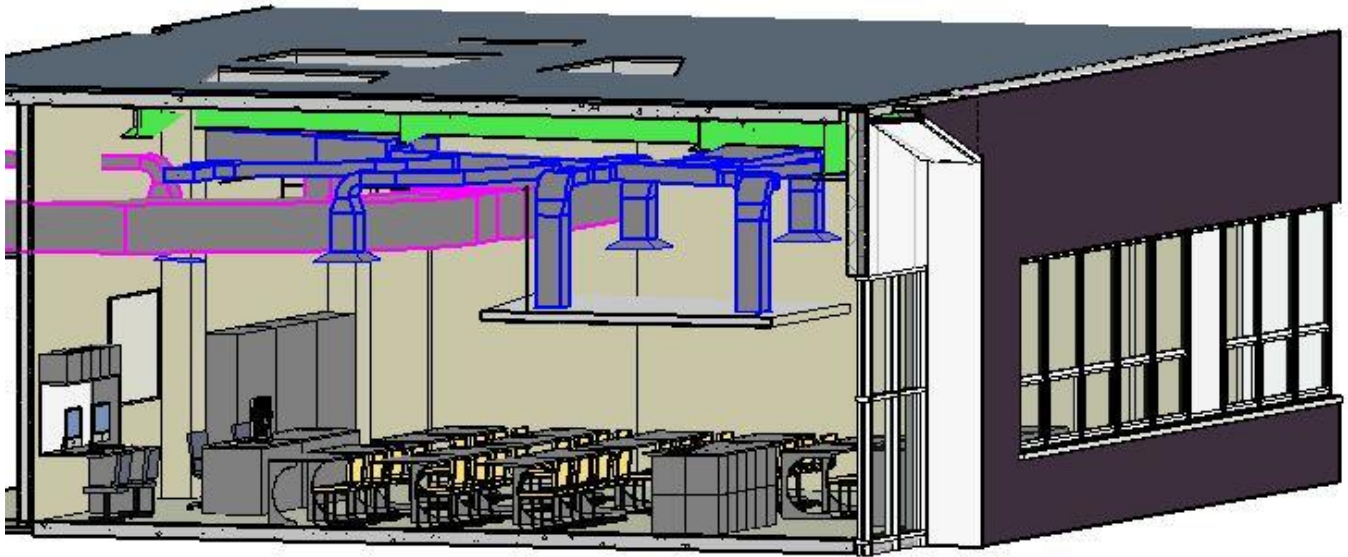
Section 4:



The two figures below show 3D section cuts to help better understand the coordination of the ceiling space in the High School Art Room.

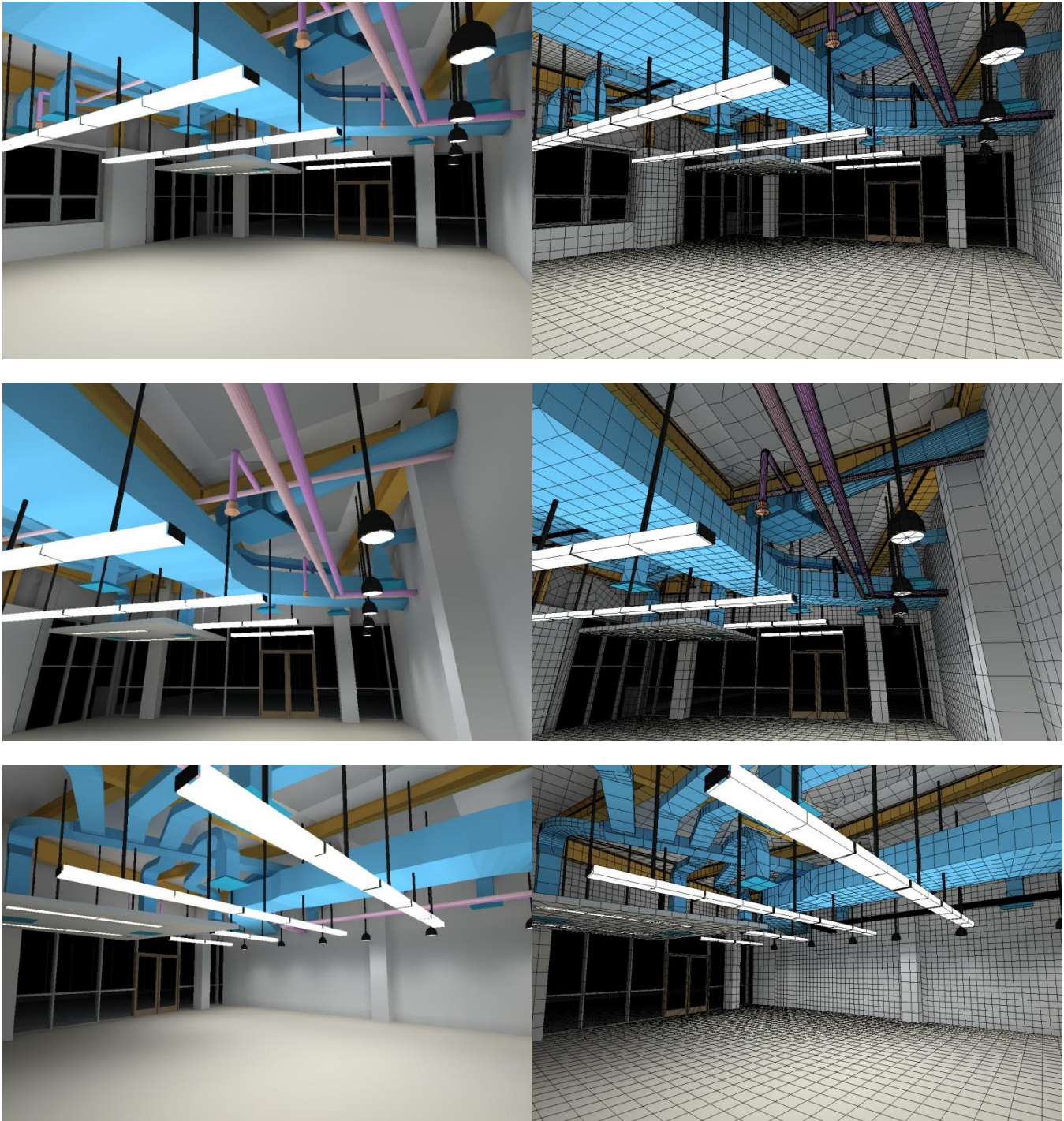


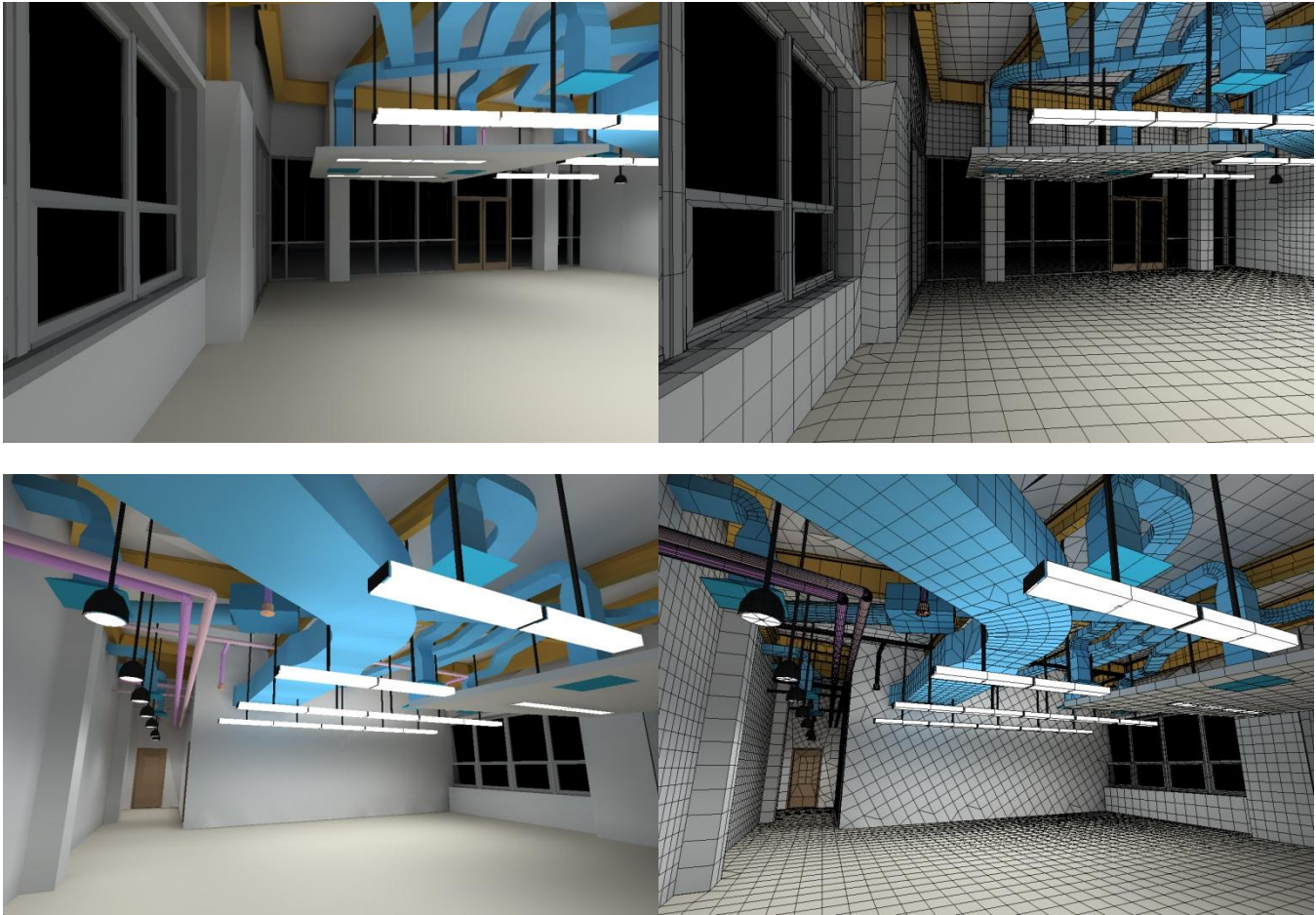
The two images below are intended to help give a better understanding of the coordination of the system in the ceiling space of the High School Art Room. The figure at the bottom is a section cut at the floor plane looking at the ceiling.



Renderings

This section shows interior renderings of the space that are intended to help give a better understanding of the coordination of the systems in the space. These renderings include only electric lighting and no daylight. They are intended to show the space under the times electric light would be utilized, which would most likely be the at night. The image on the left shows the rendering; the image on the right shows the calculation mesh.





Conclusion

Based upon the material presented in this section, it is a fair assumption to say that the redesign and coordination of the MEP systems in the ceiling space of the High School Art Room has been effective. The systems have been coordinated such that a reduction in skylight obstruction of 38% has been achieved. In addition, the reduction of skylight obstruction has resulted in an increase of 40% in workplane (average) illuminance.

Conclusion

Summary

The work presented in this report will help better increase the overall design aesthetic and community feel of the Hunters Point School. The building design overall will contribute to its connection with the neighborhood, and hopefully become a large part of the community. The building may serve as a wayfinding device and landmark for those traveling along the river. Becoming part of the neighborhood, the design goal of connection the **building + community** will be achieved.

The designs of the spaces, especially that of the auditorium, will hopefully encourage student from both programs, the intermediate school program and the high school program, to interact with one another. The goal in choosing the auditorium to design was because it is a literal connection point between the two floors that house these separate programs. Encouraging the students to interact in the space via plays, musicals, talent shows, and other events will achieve the overall design goal of connecting **people + programs**.

All designs were mindful of the architecture, especially that of the auditorium. However, it is the high school art room that truly integrates lighting and architecture. The removal of the drop-ceiling, exposing the MEP systems in the ceiling space, and adding skylights in the roof all truly merge lighting and architecture. Combining both lighting and architecture, in harmony, to create a pleasant, beautiful indoor built environment achieves the overall design goal of connecting **lighting + architecture**.

In general, this building will become a more interesting, occupant friendly building. The façade will invite people. The auditorium will intrigue them. The high school art room will fascinate and inspire them. The intermediate school cafeteria will provide them nourishment in an interesting and beautifully lit space.

References

Software

2. AGI32
3. AutoCAD 2010
4. 3DStudioMAX
5. TRACE700
6. REVIT MEP 2012
7. Adobe Photoshop CS5
8. DAYSIM 3.0

Textbooks

Houser, Mistrick, and Stefy. The IESNA Lighting Handbook: Reference & Application. 10th ed. New York, NY: Illuminating Engineering Society of North America, 2011.

The IES Lighting Handbook was used as an aid in design, daylight calculations and studies, illuminance recommendations, and for answers to general lighting questions.

National Electric Code 2011, Quincy, MA: National Fire Protection Association, Inc. 2011

The NFPA National Electric Code was used for all phase-wire, ground-wire, neutral-wire, and conduit sizing. In addition, the code was used to find full load amps of 3-phase squirrel-cage motors.

ASHRAE Standard 90.1-2010. Atlanta, GA: American Society of Heating, Refrigerating and Air Condition Engineers, Inc. 2010

ASHRAE Standard 90.1 was used for power density values for all lighting spaces. Power densities, in combination with calculated areas, were used to calculate the max wattage of lighting that could be used in each space.

ASHRAE Standard 55-2007. Thermal Environmental Conditions for Human Occupancy. Atlanta, GA: American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.

ASHRAE Standard 55 was used to locate human loads on the heating and cooling systems. These values were used in the TRACE model that was utilized in my mechanical breadth

RS Means Electrical Cost Data 2010. 33th Annual Edition. Kingston, Massachusetts: RS Means Co., 2010. Print.

RS Means electrical cost data was used for **ALL** electrical cost information used in this report. The primary use of this book was in electrical depth 1 in which a cost comparison was made between two electrical distribution methods.

Acknowledgements

I would like to personally thank the following people for both their help not only throughout thesis, but also throughout my college career.

My Professors:

Dr. Kevin Houser

Dr. Richard Mistrick

Professor Ted Dannerth

Professor Sean Good

Professor Robert Holland

Professor Kevin Parfitt

Of these people, I would like to send a personal token of gratitude to Dr. Mistrick and Dr. Houser. I cannot begin to explain how honored I am to have had the privilege and opportunity to study under you.

I would like to thank SKANSKA for providing my thesis project. A big thank you goes out to Sharvil Patel at SKANSKA for all of his help during this whole process.

Lastly, I have to send the biggest thanks of all to my mother. I would not have succeeded thus far without her. She is the main reason I am who I am, and the sole reason for my achievements and success. I dedicate this thesis and my past 5 years of college to her.

Thank you mom, I love you.

Appendix A: Lighting cut sheets

TYPE: A1

LEDIA LL OD 36" LED Illuminating Strip

Project Name

Address

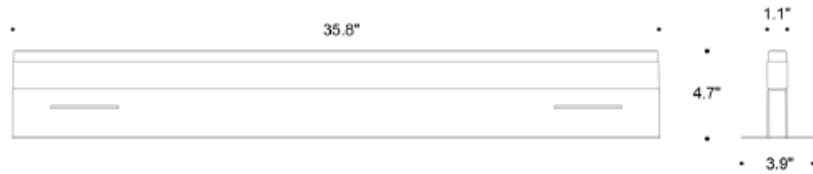
City

State

ZIP



Dimensions



LEDIA LL OD 36" LED Illuminating Strip

Luminaire Weight = 14 lbs

www.hessamerica.com

Type	Model	Length	Volt	Color	Option
	LEDIA-LL-OD	36	12 - 12 Volt DC	R - Red B - Blue G - Green A - Amber W - White (6500K)	DIM - Dimming Module N - None

Ordering Information

Comment


Specifications are subject to change without notification

HessAmerica . P.O. Box 28 . Gaffney, SC 29342 . Phone: 864-487-3535 . Fax: 864-487-3175 . www.hessamerica.com



TYPE: A1

Specifications

DESCRIPTION	LED illuminating strip for exterior recessed inground use.
HOUSING	Machined tempered glass lens is 0.75" thick and bonded to the stainless steel luminaire housing providing a sealed enclosure. Exterior surface of lens is polished with chamfered edges. Underside of lens is diffused. LED light engine housing is constructed of stainless steel. All internal components are sealed to prevent moisture entry. Luminaire mounts into stainless steel sub-frame where electrical connections are made. Luminaire is supplied with removable extruded aluminum form for rough-in installation. Recessed frame and removable form may be preshipped upon request.
OPTICS	Low wattage LED's provide even illumination across the entire lens surface.
ELECTRICAL	Remote 80w LED driver is sold separately and may be used to power multiple luminaires. Universal voltage LED driver accepts 100v through 277v, 50/60 Hz input and provides 12v DC to luminaire. Driver shall have a high power factor rating greater than 95%. Maximum power consumption is 71 watts. UL Recognized driver has a minimum start temperature is -25°C(-13°F) and maximum ambient rating of 38°C (100°F).
LAMPING	Luminaire is supplied with pigtail connectors and waterproof wire nuts. Wiring from LED power supply to luminaire and wiring between luminaires shall be supplied by others. Optional dimming module, suitable for dry locations, is available and requires a 10v DC voltage controller (by others). Total power consumption is 12 watts. Colors are available in red, blue, green, amber, and white (6500K) NOTE : Due to rapid and continuous advances in LED technology, LED luminaire data is subject to change without notice and at the discretion of HessAmerica. Consult factory for more current technical data.
WARRANTY	Limited product warranty period is three years. LED driver (ordered separately) and optional dimming module shall carry the respective manufacturer's limited warranty.
CERTIFICATION	 Listed 1838, Low Voltage Landscape Lighting Systems

Specifications are subject to change without notification

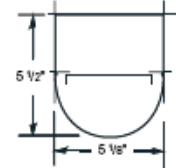
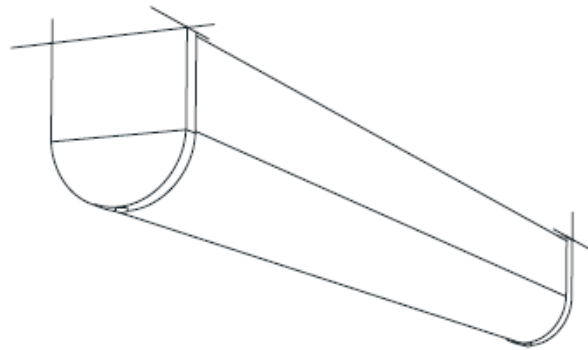
HessAmerica . P.O. Box 28 . Gaffney, SC 29342. Phone: 864-487-3535 . Fax: 864-487-3175 . www.hessamerica.com

.hess

TYPE: B1

Type
Job Name
Catalog Number

P5160 Special Applications



ordering

series	lamp rows	nominal length	shielding	color/finish	voltage	options
P5100 damp	1T8	02'	WA [‡] white acrylic diffuser	TMW textured matte white	120	AL
P5160 [‡] wet	2T8	03'	HWA high-impact white acrylic diffuser	YGW [‡] gloss white	277	EML-DL [‡]
		04'		Y__ premium color	347	EMH-DL [‡]
		06'		CC custom color	UNV [‡]	DM
		08'	[‡] standard		[‡] 120-277	RSE
						10THD
						B__
						FH
						TRS
						[‡] consult factory for fixture lengths < 4'

Applications Stairwells, under canopies, locker rooms, warehouses, parking garages.

Features A heavy-duty, surface-mounted radial lens luminaire suitable for both indoor or outdoor under-canopy applications. It offers an available aluminum housing as well as tamper-resistant screws.

Construction The housing, available in 2-, 3-, 4-, 6- or 8-foot standard lengths, is made of die-formed, 20-gauge steel finish plates. An aluminum body is also optional.

Finish The standard exterior body color is gloss white (YGW) or optional textured matte white (TMW) using polyester powder paint. Refer to the Color Selector for paint colors.

Electrical T8 fixtures have instant-start electronic ballasts with less than 20% THD. P5100 is U.L. Damp labeled; P5160 is U.L. Wet labeled for under covered ceiling applications and I.B.E.W. manufactured. Maximum ballast size available: 2.4" width x 1.5" height.

Mounting Fixture is to be surface- or wall-mounted.

Options AL: aluminum body; EML: emergency battery (600-700 lumens); EMH: emergency battery (1100-1400 lumens); DM: dimming (specify manufacturer, voltage and other requirements); RSE: rapid-start electronic; 10THD: ballast with < 10% total harmonic distortion; B__: specific ballast, specify manufacturer and catalog number (consult factory); FH: fixture fusing (slow blow); TRS: tamper-resistant screws.

© 2010 P5100

0908

Prudential Ltg. 1737 East 22nd Street, Los Angeles, CA 90056 7/11

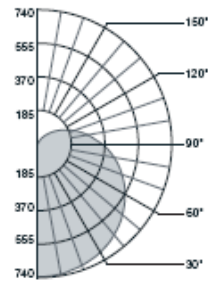
TYPE: B1

Special Applications **P5160**

photometric data

P-5160-2T8-04-WA

Report # L51132 D-5,2% I-4,3%
Spacing Criteria Along 1.51 Across 1.4
Lamp Lumens: 2950 Input Watts: 57



Candlepower Summary

Vertical Angle	Horizontal Angle				Output Lumens
	0°	22.5°	45°	67.5° 90°	
0	737	737	737	737	737
5	734	738	736	733	736
15	710	715	717	720	723
25	661	669	682	697	705
35	588	603	635	665	696
45	495	520	574	637	635
55	381	424	502	560	584
65	256	322	425	490	526
75	124	223	345	430	460
85	17	136	260	358	380
90	0	98	230	318	350
95	0	72	195	280	310
105	0	38	138	214	243
115	0	19	92	153	178
125	0	7	57	104	120
135	0	0	28	58	70
145	0	0	8	22	32
155	0	0	0	1	6
165	0	0	0	0	0
175	0	0	0	0	0
180	0	0	0	0	0

Zonal Lumen Summary

Zone	% Lamp	% Luminaire
0-90	45.67	85.19
90-180	8.47	14.82

Efficiency - 37.2%

Luminaire Summary (cd/m²)

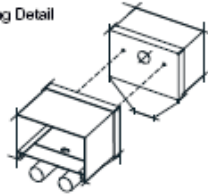
Angle	0°	45°	90°
45	4386	4701	4833
55	4166	4697	4836
65	3791	4659	4855
75	3013	4615	4873
85	1194	4527	4757

Coefficients of Utilization (%)

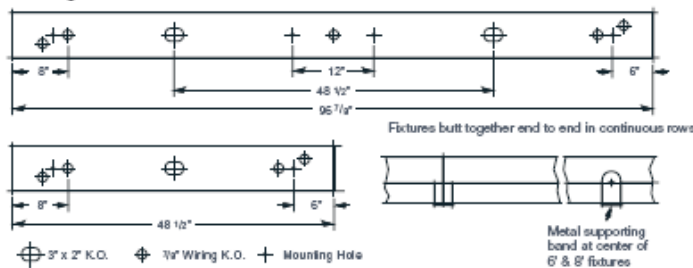
Floor	effective floor cavity reflectance - .20				
Ceiling	80	70	60	50	40
Wall	70	60	50	40	30
RCR 0	66	66	66	63	63
1	59	53	50	46	43
2	53	48	43	39	35
3	48	41	36	32	28
4	44	37	31	27	23
5	40	32	27	23	19
6	37	29	23	19	15
7	34	26	20	17	13
8	31	23	18	14	11
9	29	21	16	12	9
10	26	19	14	11	8

installation


Adjoining Detail




Mounting Locations



TYPE: C1



Catalog #	Comments
Project	Prepared By
Type	Date



LED
LEDEON

Flexible LED
Neon Alternative

2.16W/Ft
Red / Yellow / Amber

2.4W/Ft
Blue / Green /
6500K White

40' Max.

DESCRIPTION

Flexible linear 24V DC LED light strip with continuous even illumination. Suitable as an alternative to neon lighting systems.

SPECIFICATION FEATURES

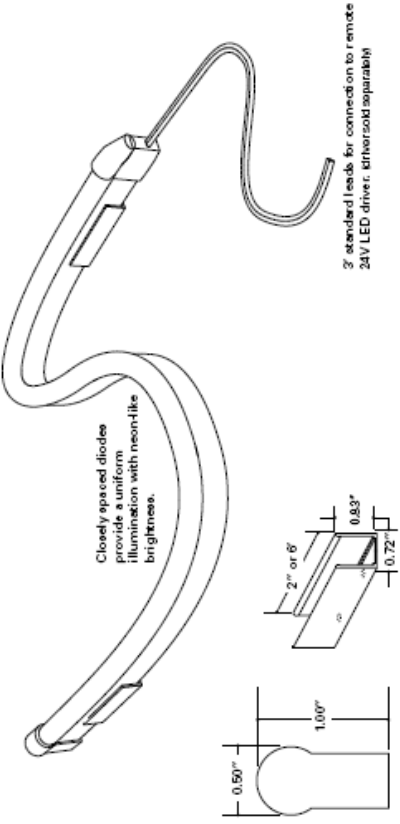
A ... Strip:
A totally flexible, sealed 24V DC LED strip for indoor and outdoor use as an alternative to neon. 40' maximum single run with 96 watt maximum load.

B ... LED:
Super bright LEDs with close 1/2" o/c spacing for uniform illumination. 2.16W/ft output in red, yellow and amber colors. 2.4W/ft output in blue, green & white colors.

C ... Mounting:
Two inch mounting clips (P9) for freeform flexed installation or six foot mounting clamps (P9C-H) for rigid linear installation are available with through holes for screw mounting.

D ... Driver:
Requires remote Class II 24V DC LED driver.

E ... Field Cuttable:
May be cut to size in the field. Cut location indicators are on the bottom of the strip and must be adhered to. Cut markers are located every 4" on red, yellow and amber strips and every 3" on green, blue and white strips.



Flexible to a radius of 0.15"

Closely spaced diodes provide a uniform illumination with neon-like brightness.

3' standard leads for connection to remote 24V LED driver. (Others sold separately)

ORDERING INFORMATION

LEDEON

Fixture: Flexible LED/LED System

Strip Length: Specify quantity

Diode Color: R = Red, B = Blue, G = Green, W = White (SMD)

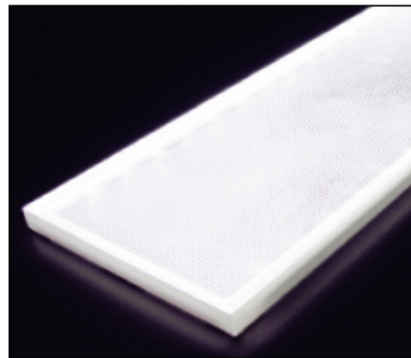
Specifications and Dimensions subject to change without notice.

RSA Lighting - 745 Ocean Ave. • Van Nuys, CA 91406 • 818-340-3030 • FAX 818-340-3031

COOPER Lighting
www.cooperlighting.com

rev. 02/2007

TYPE: D1



CUSTOM LITEPAD

A low-voltage light source providing even, indirect illumination. LitePad consists of an acrylic sheet with white LEDs directed through a patented system of amplifying light channels.

LitePad's solid-state construction enables fabrication of virtually any shape or size. At a slim 8mm thick, designers can integrate LitePad into a multitude of applications where illumination is desired.

Available in DL or HO (33% brighter) configurations. Rosco Project Consultants are available to help you determine your project needs.

Features

- LED Type: .25 Watt Surface Mounted Diode
- Construction: Optical Grade Clear Acrylic
- Panel Thickness: 8mm (0.3 in)
- Weight: 900g (2 lbs) / foot²
- Operational Temperature: -30°C min to 70°C max
- Estimated Lifespan: 50,000+ hours
- Operating Voltage: 12 Volt DC
- Warranty: 2 Years



Optical Properties

- LED Spacing Options:
DL: 18 LED's per linear foot
HO: 24 LED's per linear foot
- LED Positioning Options: LED ribbon may be located on 1, 2 or 4 sides of panel depending on the desired level of brightness.
- Color Temperature Options:
5300°K 3700°K 2800°K

Physical Properties

- Single Panel Size:
Max: 48"W x 96"L (1219mm x 2438mm) (tileable)
Min: 1.5"W x 1.5"L (38mm x 38mm)
- Shaping:
LitePads can be factory cut into just about any flat shape imaginable. As well, they can be drilled or tooled anywhere across the interior surface within 1 inch of it's edge.
- Heat Control:
An integral aluminum heat sink is mounted on the rear of the panel to disperse heat build-up, reducing the need for external cooling and prolonging service life.
- Thin Film Reflector:
LitePads include a reflective opaque white backing to maximize optical brightness and distribution of light.
- IP Rating:
- IP61



Ordering Information

LED Spacing	Color Temperature	Size	LED Placement
DL HO	5300K 3700K 2800K	Length x Width (inches/mm) Diameter CS - Custom shape <small>(drawing may be required)</small>	L1 - 1 Long Edge L2 - 2 Long Edges S1 - 1 Short Edge S2 - 2 Short Edges A4 - All 4 Sides DIA - Diameter CI - Custom Illumination
Example: HO - 5300K - 3x3 - L1			

Contact customlitepad@rosco.com for specification questions

Date: _____ Type: _____
 Firm Name: _____
 Project: _____

www.rosco.com

V 1.2

TYPE: D1

Electrical Properties

- **Power Consumption:** .25 watts per LED
- **Coordination:** Panels may be wired together in parallel not series. Each panel must have direct connection to a power supply.
- **Power Supply:** Rosco has a complete range of approved power supplies to meet your project requirements.
- **Dimming/Control:** Rosco can provide a full suite of dimming and control accessories to complement your custom LitePad.
- **Wire Placement:** The point of wire entry is customizable to accommodate your projects tiling requirements.
- **Cord Length:** LitePad comes standard with a 4' power cable with barrel connector. This is customizable based upon the needs of your project.



rosco architectural

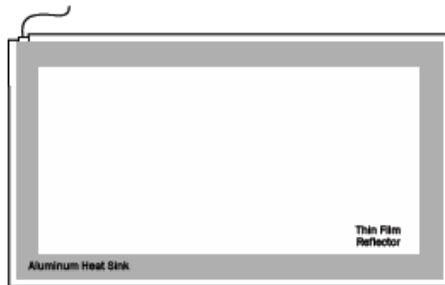
Acrylic Properties

- **Flammability Classification:** 94HB
- **Smoke Density (D2843)** 4-10%
- **Deflection:** LitePad may bow if the panel area is too large. Broad sheets should be supported every 30 inches in any direction.

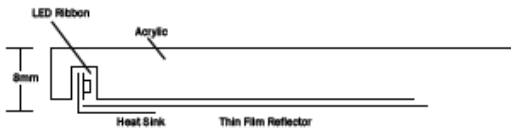
Typical LitePad Front View



Typical LitePad Back View



Typical LitePad Side View



www.rosco.com

TYPE: F1

INVUE®

DESCRIPTION

PHOCUS defines the ultimate floodlighting solution; powerful performance, easily concealable size and a stunningly beautiful shape. Available in wattages up to 150 watt T6 Metal Halide. PHOCUS is versatile in application. Ground, wall, ceiling, burial and remote mounting configurations offer a wide variety of application alternatives to accomplish specific design requirements. Offering seven (7) uniquely shaped optical distributions, plus an array of HID and Quartz Halogen PAR lamps, PHOCUS is unrivaled in its optical versatility. An available family of light control accessories provides custom cutoff solutions to meet specific distribution requirements.

SPECIFICATION FEATURES

Construction

HOUSING: One-piece, die-cast aluminum housing maintains a nominal .125" wall to endure the toughest environments while maintaining precise tolerance control. Cast indicator mark on backside of housing reference 2.5 degree internal aiming marks on yoke arm for precise vertical aiming control. **DOOR:** Die-cast aluminum door maintains a nominal .125" wall thickness. Door is secured with two (2) tamper resistant recessed stainless steel fasteners. Lens is impact resistant .20" tempered clear contoured glass, sealed to the door with a one-piece molded silicone gasket. **YOKE ARMS:** Heavy-duty die-cast aluminum yoke utilizes a taper-lock adjustment mechanism for both solid attachment and infinite aiming. Vertical adjustment is made via one (1) captive stainless steel fastener consistent with doorframe fasteners. Tested in all planes to sustain 3G of vibration.

BASE ASSEMBLY

Die-cast aluminum base assembly grounds yoke arms and allows for 357 degrees of horizontal rotation. Base assembly includes angle increment markers spaced at 2.5 degree intervals for ease of aiming, and an internal cast stop to prohibit rotation beyond one full revolution. Continuous silicone gaskets prevent water intrusion into base.

Electrical

INTEGRAL BALLAST BOX: Die-cast aluminum ballast enclosure attaches to mounting surface with two (2) 3/8" stainless steel lag bolts. Wiring compartment features a removable cover and is completely sealed from electrical components to prevent water or vapor entry into the fixture. Standard silicone-filled wire nuts prevent wicking of water through wire leads. Continuous silicone gasketing throughout base assembly forbids contaminant entry. **ELECTRICAL COMPONENTS:** Choice of high power factor (HPF) magnetic, or superior performing electronic HID ballasts.

Optical

OPTICAL SYSTEMS: Choice of seven (7) high efficiency optical systems constructed of highly reflective anodized aluminum sheet, or bright anodized polished spun aluminum. Available distributions include Narrow Spot Axial, Horizontal Narrow Flood, Horizontal Medium Flood, Horizontal Wide Flood, Vertical Narrow Flood, Vertical Medium Flood, and Vertical Wide Flood. Pulse Start Metal Halide available in a variety of beam spreads. Pulse Start Metal Halide T6 lamps feature G12 lampholders. Pulse Start Metal Halide PAR-20 lamps feature medium screw base lampholders.

Finish

Fixtures and accessories are finished in a premium 5 stage TGIC polyester powder coat paint, 2.5 mil nominal thickness for superior protection against fade and wear. Standard colors include black, bronze, gray, white, dark platinum, and graphite metallic. RAL and custom color matches available. Consult your INVUE Lighting Systems Representative for more information.

Catalog #	Type
Project	
Comments	Date
Prepared by	

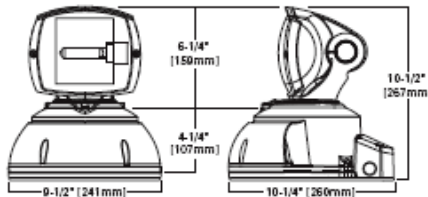


PHH
PHOCUS FLOOD

39 - 150W
Pulse Start Metal Halide

ARCHITECTURAL
FLOOD LUMINAIRE

DIMENSIONS



WATTAGE TABLE

Lamp Type	Wattage
Pulse Start Metal Halide T6	39, 70, 100, 150W
Pulse Start Metal Halide PAR20	39W

CERTIFICATION DATA

IP66 Rated
UL Listed
2G Vibration Tested
CSA Listed
25°C Ambient Temperature Rating
ISO 9001

SHIPPING DATA

(Approximate)
Net Weight (lbs.): 10



AU082427 pc
2010-08-28 14:45:52

TYPE: F1

PHH PHOCUS FLOOD


ORDERING INFORMATION

Sample Number: PHH-150-MH-120-MB-HNF-GIB-BK-L

<p>Product Family PHH-PHOCUS HD</p>	<p>Voltage ¹</p> <p>120-120V 208-208V 240-240V 277-277V 347-347V</p> <p>DT- Dual-Tap wired 277V² MT- Multi-Tap wired 277V³ TT- Triple-Tap wired 347V⁴</p>	<p>Ballast</p> <p>MB-Magnetic Ballast EB-Electronic Ballast⁵</p>	<p>Color ¹⁰</p> <p>BK-Black AP-Grey BZ-Bronze WH-White DP- Dark Platinum GM- Graphite Metallic VR- Verde Green</p>	<p>Accessories ¹¹</p> <p>VA3003-XX-Color Filter Adapter with Red Gel VA3004-XX-Color Filter Adapter with Bright Blue Gel VA3005-XX-Color Filter Adapter with Deep Green Gel VA3006-XX-Color Filter Adapter with Warm Orange Gel VA3001-XX-Top View VA3002-XX-Four Sided Shield VA3007-XX-Wire Guard</p>
<p>Lamp Wattage</p> <p>35-35W 70-70W 100-100W 150-150W</p>	<p>Lamp Type</p> <p>MP- Pulse Start Metal Halide</p>	<p>Optical System</p> <p><u>HID Lamps</u></p> <p>NS- Narrow Spot HNF-Horizontal Narrow Flood HMF-Horizontal Medium Flood HWF-Horizontal Wide Flood VNF-Vertical Narrow Flood VMF-Vertical Medium Flood VWF-Vertical Wide Flood</p> <p><u>HID PAR Lamps</u> ⁷</p> <p>SP10- 10" Spot FLS0- 30" Flood</p>	<p>Options ¹¹</p> <p>F- Single Fuse (120, 277 or 347V)¹² Specify Voltage FF- Double Fuse (208, 240 or 480V)¹² Specify Voltage FR- Frosted Flat Glass Lens L- Lamp Included</p>	
<p>Mounting</p> <p><u>Ground Mount</u></p> <p>GBB-Direct In-Ground Mount (supplied w/ in-ground box and ballast)⁸ GIB- Integral Ballast Box GRB-Remote Mount (supplied w/ remote in-ground box and ballast)⁸ GRNB-Remote Mount (requires remote potted ballast and ballast box by⁹ others) GSR-Spike Mount (supplied w/ remote in-ground box and ballast)⁸</p> <p><u>Wall/Ceiling Mount</u></p> <p>WIB-Integral Ballast Box WRNB-Remote Mount (requires remote potted ballast and ballast box by others)</p>				

Notes:

- 1 Products also available in non-US voltages and 60Hz for international markets. Consult factory for availability and ordering information.
- 2 Magnetic ballasts only.
- 3 Dual-tap is 120/277V wired 277V.
- 4 Multi-tap is 120/208/240/277V wired 277V.
- 5 Triple-tap is 120/277/347V wired 347V.
- 6 100 through 277V only. Not available with 150 MP lamp, or GBB, GRB, GSR ground mount options.
- 7 PAR 20 MP lamps available in 35W only.
- 8 GBB, GRB, GSR mounting options include a magnetic potted in-ground ballast enclosure. Not available in 150W MP. Maximum 60' mounting distance from fixture head.
- 9 For use when ground mounting in non-vent or interior surface environments.
- 10 Custom and RAL color matching available upon request. Consult your INVUE Lighting Systems Representative for further information.
- 11 Add as suffix in the order shown.
- 12 Fusing available on GIB and WIB mounting options only.
- 13 Order separately, replace XX with color suffix.



www.cooperlighting.com

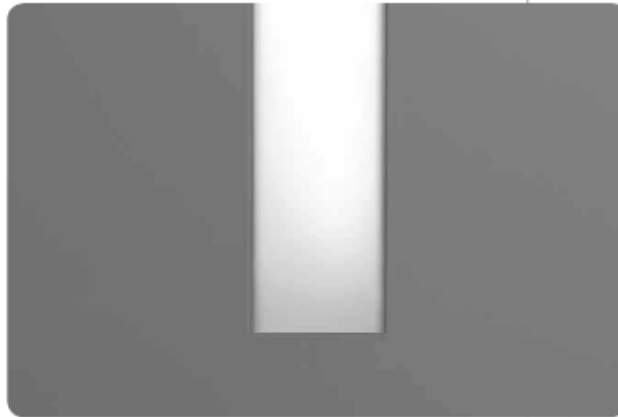
NOTE: Specifications and dimensions subject to change without notice.
Visit our web site at www.cooperlighting.com

Customer First Center 1121 Highway 74 South Peachtree City, GA 30289 770.486.4800 FAX 770.486.4801

AV/083427 pc
2010-08-28 14:45:52
2011-04-29 10:09:28

TYPE: A2

recessed wall mount
seem® 4



features

Narrow 4" aperture slot fluorescent luminaire that integrates with wall for a clean unobtrusive aesthetic.

Frosted acrylic flush lens provides even illumination.

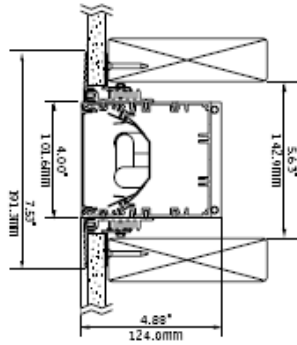
Allows for individual and continuous row mount in trimless drywall applications.

Available in 1 lamp T5 or T8 configurations, Seem 4 provides continuous illumination by combining 3' and 4' staggered lamps.

companion luminaires



dimensional data

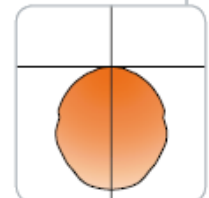


notes: designed for 2"x6" construction
0.375"min - 2.125"max material thickness

September 2011 G

performance

1-Lamp T5
56% Efficiency
595 cd @ 0°

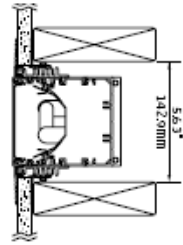


Visit focalpointlights.com for complete photometric data.

TYPE: A2

fixture:
project:

mounting information



notes: designed for 2 1/2" construction
0.375" min - 2.125" max drywall thickness

specifications

construction

One piece, .07" thick housing of 6063-T5 extruded aluminum.
16 Ga. Internal bulkhead, 20 Ga. steel end caps.
Luminaires include trimless aluminum flange.
Lengths 6' and longer configured with staggered lamps:

- 1-lamp T8: 4.47" overlap
- 1-lamp T5/T5HO: 4.35" overlap

- 2' unit weight: 18 lbs.
- 3' unit weight: 24 lbs.
- 4' unit weight: 30 lbs.
- 5' unit weight: 36 lbs.

optic

Reflectors fabricated of 22 Ga. steel finished in High Reflectance White powder coat.
Flush satin lens: extruded acrylic lens .07" thick with opal satin finish.

electrical

Luminaires are pre-wired with factory installed branch circuit wiring and over-molded quick connect.
Electronic fluorescent ballasts are thermally protected and have a Class "P" rating.
Optional dimming ballasts available.
UL and cUL listed.

finish

Polyester powder coat applied over a 5-stage pre-treatment.

ordering

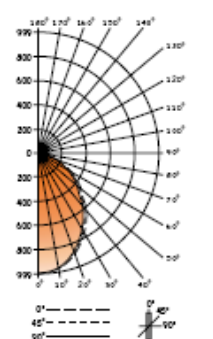
luminaire series	FSM4
Seem 4	FSM4
shielding	FL
Flush Satin Lens	FL
lamping	
One Lamp T8	1T8
One Lamp T5	1T5
circuits	1C
Single Circuit	1C
voltage	
120 Volt	120
277 Volt	277
347 Volt	347
ballast	
Electronic Instant Start <20% THD (T8 only)	E
Electronic Program Start <10% THD	S
Electronic Dimming Ballast*	D
mounting	
Mud-In Trimless, pre-set for 1/2" Drywall	XF1
Mud-In Trimless, pre-set for 5/8" Drywall	XF2
Mud-In Trimless, set thickness in field (mounting equipment assembled in field) (2.125" max, .375" min ceiling/wall thickness. Suitable for both wall and ceiling applications.)	XFF
factory options	
Emergency Circuit*	EC
Emergency Battery Pack*	EM
Flex Whip*	FW
HLR/GLR Fuse	FU
Include 3000K lamp	L830
Include 3500K lamp	L835
Include 4100K lamp	L841
finish	WH
Matte White	WH
luminaire length (lengths are nominal)	
Specify wall and ceiling lengths in 1' increments (lengths 6' and longer configured with staggered lamps.) (Consult factory for dimming)	X'

Field Point, LLC | 14001 S. Pulaski Rd., Chicago, IL 60621 | T: 773.267.9999 | F: 773.267.9999 | info@fieldpointlighting.com | www.fieldpointlighting.com
 Field Point, LLC reserves the right to change specifications for product without notice.

* for more information see Reference section.

TYPE: A2

seem™ 4



Spacing: 1.1
Criterion: 1.1

File Name: FSM4FLXP1TS.IES
Catalog #: FSM4-FLXP-1TS-1C-120-S-G1-WH-4"
Efficiency: 77%
Task #: 15712.0

CANDLEPOWER DISTRIBUTION

Vertical Angle	0°	22.5°	45°	67.5°	90°	Zonal Lumens
0°	999	999	999	999	999	999
5°	997	996	994	994	994	95
15°	942	941	937	93	931	266
25°	831	827	817	806	802	378
35°	692	685	670	654	648	421
45°	510	503	484	466	458	375
55°	378	373	355	338	333	319
65°	236	23	219	210	205	219
75°	118	116	111	105	103	117
85°	31	29	28	28	28	31
90°	0	0	0	0	0	0
95°	0	0	0	0	0	0
105°	0	0	0	0	0	0
115°	0	0	0	0	0	0
125°	0	0	0	0	0	0
135°	0	0	0	0	0	0
145°	0	0	0	0	0	0
155°	0	0	0	0	0	0
165°	0	0	0	0	0	0
175°	0	0	0	0	0	0
180°	0	0	0	0	0	0

LUMEN SUMMARY

Zone Lumens	% Lumens	% Footcandle		
0-30°	738	25.5	33.3	
0-40°	1359	40.0	52.2	
0-60°	1853	63.9	83.5	
0-90°	2220	76.6	100	
Total Luminaire	0-180°	2220	76.6	100

LUMINANCE DATA (CD/M²)

Vertical Angle	0°	45°	90°
45°	6091	5781	5470
55°	5566	5227	4903
65°	4716	4376	4097
75°	3850	3622	3361
85°	3004	2713	2713

CO-EFFICIENTS OF UTILIZATION

Floor	80	70	30	30	30	00										
Ceiling	70	50	30	10	70	50	10	50	10	50	10	50	10	50	10	00
Wall	70	50	30	10	70	50	10	50	10	50	10	50	10	50	10	00
RCR0	91	91	91	91	89	89	89	85	85	81	81	78	78	77	77	77
1	85	81	78	76	82	80	75	74	72	73	70	71	68	67	67	67
2	78	72	68	64	76	71	63	63	62	66	60	64	59	58	58	58
3	72	65	59	55	70	64	54	61	53	59	53	58	52	50	50	50
4	66	58	52	47	65	57	47	55	46	54	46	52	45	44	44	44
5	61	52	46	41	59	51	41	49	40	48	40	47	39	38	38	38
6	56	47	40	36	55	46	36	45	35	44	35	42	35	33	33	33
7	52	42	35	32	51	42	32	41	31	40	31	39	31	29	29	29
8	48	38	32	28	47	38	28	37	27	36	27	35	27	26	26	26
9	45	35	28	24	43	34	24	33	24	32	24	32	24	22	22	22
10	41	31	26	22	40	31	22	30	21	30	21	29	21	20	20	20

*Numbers indicate percentage utilization of this fixture.

Go to www.focalpointlights.com for additional photometric data.

seem™ 4



Spacing: 1.2
Criterion: 1.2

File Name: FSM4FL1TS.IES
Catalog #: FSM4-FL-1TS-1C-120-S-G1-WH-4"
Efficiency: 56%
Task #: 15711.0

CANDLEPOWER DISTRIBUTION

Vertical Angle	0°	22.5°	45°	67.5°	90°	Zonal Lumens
0°	595	595	595	595	595	595
5°	591	591	591	591	591	56
15°	568	568	568	568	568	161
25°	515	515	515	515	515	238
35°	455	455	455	455	455	286
45°	353	353	353	353	353	275
55°	288	288	288	288	288	259
65°	198	196	198	198	199	196
75°	108	109	109	109	109	115
85°	28	28	28	28	29	31
90°	0	0	0	0	0	0
95°	0	0	0	0	0	0
105°	0	0	0	0	0	0
115°	0	0	0	0	0	0
125°	0	0	0	0	0	0
135°	0	0	0	0	0	0
145°	0	0	0	0	0	0
155°	0	0	0	0	0	0
165°	0	0	0	0	0	0
175°	0	0	0	0	0	0
180°	0	0	0	0	0	0

LUMEN SUMMARY

Zone Lumens	% Lumens	% Footcandle		
0-30°	456	15.7	28.2	
0-40°	742	25.6	45.9	
0-60°	1275	44.0	78.9	
0-90°	1617	55.8	100	
Total Luminaire	0-180°	1617	55.8	100

LUMINANCE DATA (CD/M²)

Vertical Angle	0°	45°	90°
45°	4216	4240	4240
55°	4241	4241	4270
65°	3957	3957	3977
75°	3524	3557	3557
85°	2713	2713	2810

CO-EFFICIENTS OF UTILIZATION

Floor	80	70	30	30	30	00										
Ceiling	70	50	30	10	50	10	50	10	50	10	50	10	50	10	00	
Wall	70	50	30	10	70	50	10	50	10	50	10	50	10	50	10	00
RCR0	66	66	66	66	65	65	65	62	62	59	59	57	57	56	56	56
1	61	59	56	54	60	57	53	55	52	53	50	51	49	48	48	48
2	56	52	48	45	54	51	44	49	43	47	42	45	41	40	40	40
3	51	46	41	38	50	45	38	43	37	42	36	40	36	35	35	35
4	47	41	36	32	46	40	32	39	32	37	31	36	31	30	30	30
5	43	36	31	27	42	35	27	34	27	33	27	32	26	25	25	25
6	40	32	27	24	39	32	24	31	23	30	23	29	23	22	22	22
7	36	29	24	21	36	29	21	28	21	28	21	26	20	19	19	19
8	34	26	21	18	33	26	18	25	18	24	18	24	18	17	17	17
9	31	23	19	16	30	23	16	22	15	22	15	21	15	14	14	14
10	29	21	17	14	28	21	14	20	14	20	14	19	14	13	13	13

*Numbers indicate percentage utilization of this fixture.

Go to www.focalpointlights.com for additional photometric data.

TYPE: A2

seem™ 4

Spacing: 1.1
Criterion: 1.1

Filename: PSM4FLXP1Ta.IES
Catalog #: PSM4-FLXP-1Ta-3C-120-5-TF-WH-4
Efficiency: 72%
Test #: 15815.0

seem™ 4

Spacing: 1.3
Criterion: 1.3

Filename: PSM4FL1Ta.IES
Catalog #: PSM4-FL-1Ta-3C-120-5-TF-WH-4
Efficiency: 82%
Test #: 15814.0

CANDLEPOWER DISTRIBUTION				LUMEN SUMMARY				LUMINANCE DATA (CD/M²)							
Vertical Angle	0°	Horizontal Angle	90°	Zone Lumens	% Lamp	% Fix	Zone Lumens	% Lamp	% Fix	Vertical Angle	0°	45°	90°		
0°	924	924	924	924	924	0.30°	698	23.7	33.0	45°	5921	5607	5341		
5°	922	920	920	920	88	0-40°	1103	37.4	52.2	55°	5363	5095	4767		
15°	890	886	883	881	877	250	0-60°	1749	60.0	83.7	65°	4489	4385	3943	
25°	791	787	779	767	762	360	0-90°	2114	71.7	100	75°	3731	3401	3302	
35°	667	659	645	630	623	405	Total Luminaire	0-180°	2114	71.7	100	85°	2843	2451	2255
45°	490	481	464	448	442	360									
55°	360	355	342	328	320	306									
65°	222	218	207	200	195	207									
75°	113	109	103	100	100	111									
85°	29	27	25	23	23	28									
90°	0	0	0	0	0	0									
95°	0	0	0	0	0	0									
105°	0	0	0	0	0	0									
115°	0	0	0	0	0	0									
125°	0	0	0	0	0	0									
135°	0	0	0	0	0	0									
145°	0	0	0	0	0	0									
155°	0	0	0	0	0	0									
165°	0	0	0	0	0	0									
175°	0	0	0	0	0	0									
180°	0	0	0	0	0	0									

CO-EFFICIENTS OF UTILIZATION			
Floor	80	70	20
Ceiling	80	30	10
Wall	70	50	30
RCR0	85	85	85
1	79	76	74
2	73	68	64
3	67	61	56
4	62	54	49
5	57	49	43
6	53	44	38
7	49	40	34
8	45	36	30
9	42	32	27
10	39	29	24

CANDLEPOWER DISTRIBUTION				LUMEN SUMMARY				LUMINANCE DATA (CD/M²)							
Vertical Angle	0°	Horizontal Angle	90°	Zone Lumens	% Lamp	% Fix	Zone Lumens	% Lamp	% Fix	Vertical Angle	0°	45°	90°		
0°	539	539	539	539	539	0-30°	426	14.4	28.0	45°	4024	4024	4073		
5°	543	543	543	543	543	52	0-40°	698	23.8	45.9	55°	4037	4037	4037	
15°	528	528	528	528	528	150	0-60°	1199	40.8	78.9	65°	3680	3720	3741	
25°	484	484	484	484	484	224	0-90°	1520	51.5	100	75°	3368	3368	3368	
35°	433	433	433	433	433	272	Total Luminaire	0-180°	1520	51.5	100	85°	2843	2843	2843
45°	333	333	333	333	337	268									
55°	271	271	271	271	271	243									
65°	182	184	184	184	185	183									
75°	102	100	102	102	102	107									
85°	29	29	29	29	29	32									
90°	0	0	0	0	0	0									
95°	0	0	0	0	0	0									
105°	0	0	0	0	0	0									
115°	0	0	0	0	0	0									
125°	0	0	0	0	0	0									
135°	0	0	0	0	0	0									
145°	0	0	0	0	0	0									
155°	0	0	0	0	0	0									
165°	0	0	0	0	0	0									
175°	0	0	0	0	0	0									
180°	0	0	0	0	0	0									

CO-EFFICIENTS OF UTILIZATION			
Floor	80	70	20
Ceiling	80	30	10
Wall	70	50	30
RCR0	81	81	81
1	56	54	52
2	52	48	44
3	47	42	38
4	43	38	33
5	40	33	28
6	37	30	25
7	34	27	22
8	31	24	19
9	29	22	17
10	27	20	15

TYPE: A2

seem® 4 & 6 run information

EXAMPLE 16' run



1-T5/T5HO



2-T5/T5HO (may exhibit noticeable socket shadows)



1-T8



2-T8 (may exhibit noticeable socket shadows)

notes:

- lamp overlap is consistent throughout run.
- unit ends vary to provide even light throughout run.
- standard configurations listed, consult factory for additional options.

TYPE: A2

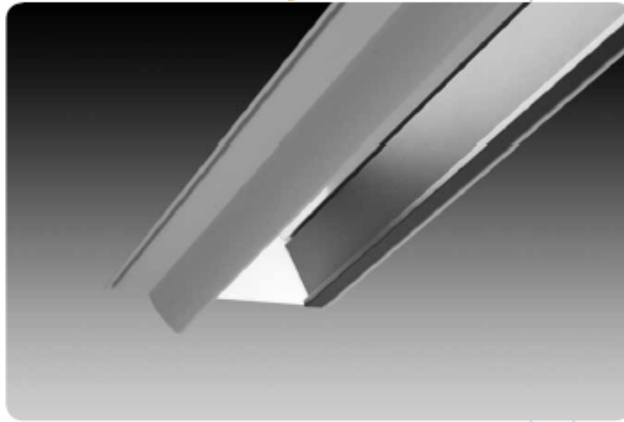
seem® 4 & 6 run information

nominal run length (ft)	1-T5/T5H0 (4.35" overlap)			2-T5/T5H0 (2.00" overlap)			1-T8 (4.47" overlap)			2-T8 (9.35" overlap)		
	lamp quantity		unlit ends (no)	lamp quantity		unlit ends (no)	lamp quantity		unlit ends (no)	lamp quantity		unlit ends (no)
	3'	4'		3'	4'		3'	4'		3'	4'	
6	2		3.5	4		0.2	2		1.8	n/a	n/a	n/a
7	1	1	3.6	2	2	0.3	1	1	1.8	4		0.8
8	3		0.5		4	0.4		2	1.8	2	2	0.8
9	2	1	0.6	6		1.1	3		4.0		4	0.9
10	1	2	0.6	4	2	1.2	2	1	4.1	6		0.8
11		3	0.8	2	4	1.3	4		0.3	4	2	0.8
12	3	1	3.7		6	1.3	3	1	0.3	2	4	0.8
13	5		0.7	6	2	2.1	2	2	0.3		6	0.8
14	4	1	0.8	4	4	2.2	1	3	0.3	6	2	0.8
15	3	2	0.8	2	6	2.3		4	0.3	4	4	0.8
16	2	3	1.0		8	2.3	3	2	2.6	2	6	0.8
17	1	4	1.1	6	4	3.0	2	3	2.6		8	0.8
18		5	1.1	4	6	3.1	1	4	2.6	6	4	0.8
19	6	1	0.8	2	8	3.2	7		1.0	4	6	0.8
20	5	2	0.8		10	3.3	6	1	1.0	2	8	0.8
21	4	3	1.0	6	6	4.0	5	2	1.1		10	0.8
22	3	4	1.1	4	8	4.1	4	3	1.1	6	6	0.8
23	9		1.1	2	10	4.2	3	4	1.1	4	8	0.8
24	1	6	0.9		12	4.3	2	5	1.1	2	10	0.8
25	7	2	1.3	6	8	4.9	1	6	1.1		12	0.8
26	6	3	1.2	18		0.3		7	1.2	6	8	0.8
27	5	4	1.3	16	2	0.3	10		1.8	4	10	0.8
28	11		1.0	14	4	0.4	9	1	1.8	2	12	0.8
29	10	1	1.1	12	6	0.6	8	2	1.8		14	0.8
30	9	2	1.2	10	8	0.7	7	3	1.8	6	10	0.8
31	8	3	1.3		16	0.2	6	4	1.8	4	12	0.8
32	7	4	1.4	6	12	0.8	5	5	1.8	2	14	0.8
33	13		1.2	4	14	0.9	4	6	1.8		16	0.8
34	12	1	1.2	2	16	1.1	3	7	1.9	6	12	0.8
35	11	2	1.3		18	1.1	2	8	1.9	4	14	0.8
36	10	3	1.4	6	14	1.8	1	9	1.9	2	16	0.8
37	9	4	1.5	4	16	1.9	7	5	0.3		18	0.9
38	15		1.3	2	18	2.0	6	6	0.3	6	14	0.8
39	14	1	1.3		20	2.1	5	7	0.4	4	16	0.8
40	13	2	1.4	6	16	2.8	4	8	0.4	2	18	0.8
41	12	3	1.6	4	18	2.8	3	9	0.4		20	0.9
42	4	11	1.7	2	20	2.9	2	10	0.4	6	16	0.8
43	5	10	1.8		22	3.1	1	11	0.4	4	18	0.9
44	9	6	1.9	6	18	3.7		12	0.4	2	20	0.9
45	8	7	1.9	4	20	3.8	3	10	2.7		22	0.9
46	7	8	2.1	2	22	3.9	2	11	2.7	6	18	0.9
47	13	4	1.8		24	4.0	1	12	2.7	4	20	0.9
48	19		1.5	6	20	4.6	7	8	1.1	2	22	0.9

reference

TYPE: B2

drywall seem® 4 asymmetric



features

Narrow 4" asymmetric slot wall wash fluorescent that integrates luminaire with ceiling for clean unobtrusive aesthetic.

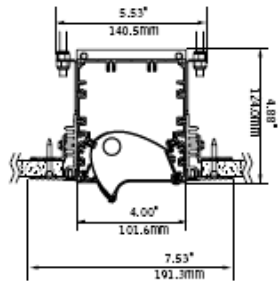
Precision micro-optic delivers shadow free illumination from ceiling to floor.

Allows for individual or continuous row mount in trimless drywall applications.

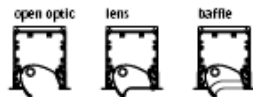
Available in 1 lamp T8, T5 or T5HO configurations.

Delivers high levels of vertical illumination to highlight artwork, white boards or displays.

dimensional data



shielding options



shielding options



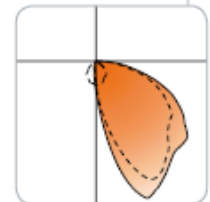
companion luminaires



October 2011 B

performance

1-Lamp T5HO - No Shielding
53% Efficiency
1690 cd @ 20°



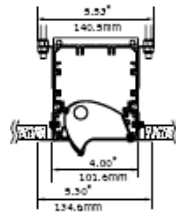
Visit focalpointlights.com for complete photometric data.

TYPE: B2

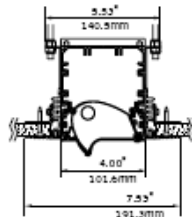
fixtures:
project:

mounting information

trim flange



trimless mud-in



Note: New construction only. Luminaires must be installed prior to drywall.

specifications

construction

One piece, .07" thick housing of 4063-T5 extruded aluminum.
16 Ga. Internal bulkhead, 20 Ga. steel end caps.
Mud-In Luminaires include trimless aluminum flange.

- 2' unit weight: 18 lbs.
- 3' unit weight: 24 lbs.
- 4' unit weight: 30 lbs.
- 5' unit weight: 36 lbs.
- 6' unit weight: 43 lbs.
- 8' unit weight: 55 lbs.

optic

.020" specular aluminum upper reflector and 0.20" semi-specular lower reflector.
Matte black extruded aluminum diffuser.
24 Ga. Steel Radial cut off baffle.

electrical

Luminaires are pre-wired with factory installed branch circuit wiring and over-molded quick connects.
Electronic fluorescent ballasts are thermally protected and have a Class "P" rating.
Optional dimming ballasts available.
UL and cUL listed.

finish

Polyester powder coat applied over a 5-stage pre-treatment.

ordering

luminaire series	<u>FSM4A</u>
Seem 4 Asymmetric	FSM4A
shielding	_____
No Shielding, Open Optic	NS
Snap-In Clear Lens	CL
Radial Cut-Off Baffle (Baffle always painted white)	RL
lampping	_____
One Lamp T8	1T8
One Lamp T5	1T5
One Lamp T5HO	1T5HO
circuits	<u>1C</u>
Single Circuit	1C
voltage	_____
120 Volt	120
277 Volt	277
347 Volt	347
ballast	_____
Electronic Instant Start <20% THD (T8 only)	E
Electronic Program Start <10% THD	S
Electronic Dimming Ballast*	D
mounting	_____
Mud-In Trimless, pre-set for 1/2" Drywall	XF1
Mud-In Trimless, pre-set for 5/8" Drywall	XF2
Mud-In Trimless, set thickness in field (mounting equipment assembled in field)	XFF
factory options	_____
Chicago Plenum	CP
Emergency Circuit*	EC
Emergency Battery Pack*	EM
Flex Whip*	FW
HLR/LR Fuse	FU
Include 3000K lamp	L830
Include 3500K lamp	L835
Include 4100K lamp	L841
finish	<u>WH</u>
Matte White	WH
luminaire length (lengths are nominal)	_____
Specify luminaire length in 1' increments (consult factory for 5' dimming)	X'

Fred Hunt, LLC, 1000 S. Plunkin, Chicago, IL 60627 | Tel: 773.297.2000 | info@fredhunt.com and fredhunt.com/leds/line
Fred Hunt, LLC reserves the right to change specifications for product representation and pricing.

* for more information see Reference section.

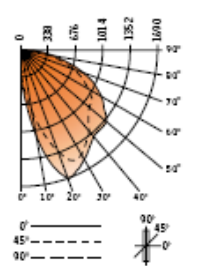
TYPE: B2

recessed asymmetric - drywall/grid
seem™ 4



Filename: FSM4ANS1TsH0.JES
Catalog #: FSM4A-NS-1TsH0-1C-120-S-G1-WH-4'
Efficiency: 53%
Task #: 16062.0

CANDLEPOWER DISTRIBUTION



Vertical Angle	0°	22.5°	45°	67.5°	90°	Zonal Lumens
0°	289	289	289	289	289	
5°	66.3	61.3	52.3	40.3	28.0	33
15°	145.9	136.3	106.4	65.9	28.5	158
25°	165.2	162.6	150.9	93.0	22.3	315
35°	148.8	148.0	141.8	111.1	19.9	424
45°	140.1	130.5	118.5	105.2	13.9	474
55°	126.4	122.6	108.3	85.7	10.5	480
65°	101.2	98.4	85.8	60.9	5.8	404
75°	63.7	61.3	53.7	40.3	3.1	274
85°	26.8	25.2	20.3	12.8	7	104
90°	14.2	12.8	8.8	3.2	0	0
95°	0	0	0	0	0	0
105°	0	0	0	0	0	0
115°	0	0	0	0	0	0
125°	0	0	0	0	0	0
135°	0	0	0	0	0	0
145°	0	0	0	0	0	0
155°	0	0	0	0	0	0
165°	0	0	0	0	0	0
175°	0	0	0	0	0	0
180°	0	0	0	0	0	0

LUMEN SUMMARY

Zone	Lumens	% Lamp	% Fixt	
0°-30°	506	10.1	19.0	
0°-40°	930	18.6	34.9	
0°-60°	1883	37.7	70.7	
0°-90°	2665	53.3	100.0	
Total Luminaires	0°-180°	2665	53.3	100

CO-EFFICIENTS OF UTILIZATION

Floor Ceiling	80				70				50						
	70	50	30	10	70	50	30	10	50	30	10	30	10	00	
RCR 0	63	63	63	63	62	62	62	62	59	59	57	57	54	54	53
1	57	55	52	50	56	53	49	51	47	49	46	47	45	43	
2	52	47	43	40	50	46	39	44	38	42	37	41	37	35	
3	47	41	36	33	43	40	32	39	32	37	31	36	31	29	
4	43	36	31	27	41	35	27	34	26	33	26	31	26	25	
5	39	31	26	22	37	31	22	29	22	28	22	27	21	20	
6	35	28	22	19	34	27	19	26	18	24	18	24	18	17	
7	32	24	19	16	31	24	16	23	16	22	16	22	15	14	
8	29	22	17	13	29	21	13	20	13	20	13	19	13	12	
9	27	19	14	11	26	19	11	18	11	18	11	17	11	10	
10	25	17	13	10	24	17	10	16	10	16	10	15	9	8	

Go to www.focalpointlights.com for additional photometric data.

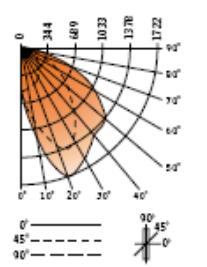
Headset (indicate percentage values of reflectivity)

recessed asymmetric - drywall/grid
seem™ 4



Filename: FSM4ARL1TsH0.JES
Catalog #: FSM4A-RL-1TsH0-1C-120-S-G1-WH-4'
Efficiency: 45%
Task #: 16063.0

CANDLEPOWER DISTRIBUTION



Vertical Angle	0°	22.5°	45°	67.5°	90°	Zonal Lumens
0°	546	546	546	546	546	
5°	81.2	79.3	72.5	63.2	53.3	55
15°	150.9	141.3	112.9	79.3	50.9	203
25°	168.1	159.3	139.5	89.2	46.5	345
35°	151.7	138.2	119.0	89.9	39.9	423
45°	141.5	115.7	85.3	67.8	29.4	414
55°	122.9	97.6	66.1	46	23.0	371
65°	85.0	64.4	36.5	21.5	15.1	248
75°	42.9	30.3	17.9	12.7	8.3	124
85°	11.6	10.6	7.9	4.9	2.1	42
90°	6.9	6.5	4.4	2.1	0	0
95°	0	0	0	0	0	0
105°	0	0	0	0	0	0
115°	0	0	0	0	0	0
125°	0	0	0	0	0	0
135°	0	0	0	0	0	0
145°	0	0	0	0	0	0
155°	0	0	0	0	0	0
165°	0	0	0	0	0	0
175°	0	0	0	0	0	0
180°	0	0	0	0	0	0

LUMEN SUMMARY

Zone	Lumens	% Lamp	% Fixt	
0°-30°	603	12.1	27.1	
0°-40°	1026	20.5	46.1	
0°-60°	1812	36.2	81.4	
0°-90°	2225	44.5	100.0	
Total Luminaires	0°-180°	2225	44.5	100

CO-EFFICIENTS OF UTILIZATION

Floor Ceiling	80				70				50						
	70	50	30	10	70	50	30	10	50	30	10	30	10	00	
RCR 0	53	53	53	53	52	52	52	52	49	49	47	47	45	45	45
1	49	47	45	44	48	46	43	44	41	42	40	41	39	38	
2	45	41	39	36	44	41	36	39	35	38	34	36	33	33	
3	41	37	33	31	40	36	30	35	30	34	29	32	29	28	
4	38	33	29	26	37	32	26	31	26	30	25	29	25	24	
5	34	29	25	22	34	28	22	27	22	27	22	26	21	20	
6	32	26	22	19	31	25	19	25	19	24	19	23	19	18	
7	29	23	19	17	28	23	16	22	16	21	16	21	16	15	
8	27	21	17	14	26	20	14	20	14	19	14	19	14	13	
9	25	18	15	12	24	18	12	18	12	17	12	17	12	11	
10	23	17	13	11	22	16	11	16	11	16	11	15	10	10	

Go to www.focalpointlights.com for additional photometric data.

Headset (indicate percentage values of reflectivity)

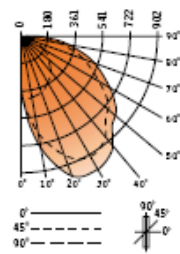
TYPE: B2

recessed asymmetric - drywall
seem™ 4



Filename: FSM4ANS0Ts.IES
Catalog #: FSM4A-NS-17s-1C-12s-S-TF-WH-4'
Efficiency: 50%
Test #: 16251.0

CANDLEPOWER DISTRIBUTION



Vertical Angle	0°	22.5°	45°	67.5°	90°	Zonal Lumens
0°	356	356	356	356	356	
5°	591	511	468	409	348	35
15°	755	726	647	519	336	106
25°	856	834	758	578	310	177
35°	837	821	762	611	275	235
45°	708	697	654	541	213	248
55°	632	611	568	479	165	292
65°	501	485	431	358	103	213
75°	356	342	293	219	50	151
85°	186	171	135	81	7	69
90°	121	108	73	30	0	0
95°	0	0	0	0	0	0
105°	0	0	0	0	0	0
115°	0	0	0	0	0	0
125°	0	0	0	0	0	0
135°	0	0	0	0	0	0
145°	0	0	0	0	0	0
155°	0	0	0	0	0	0
165°	0	0	0	0	0	0
175°	0	0	0	0	0	0
180°	0	0	0	0	0	0

LUMEN SUMMARY

	Zonal Lumens	% Lamps	% Fld
0°-30°	318	10.8	21.4
0°-40°	552	18.7	37.2
0°-60°	1053	35.7	70.8
0°-90°	1486	50.4	100
Total Luminaires	0°-180°	1486	50.4 100

CO-EFFICIENTS OF UTILIZATION

Floor Ceiling	80			70			50			30			00		
	70	50	30	10	70	50	10	50	10	30	10	50	30	10	00
RCR 0	60	60	60	60	59	59	59	56	56	54	54	51	51	50	50
1	54	52	49	47	53	50	48	48	45	46	43	44	42	41	41
2	49	45	41	38	48	44	37	42	36	40	36	39	35	34	34
3	45	39	35	31	43	38	31	37	30	35	30	34	29	28	28
4	41	34	30	26	39	34	26	32	26	31	25	30	25	24	24
5	37	30	25	22	36	29	22	28	21	27	21	26	21	20	20
6	34	27	22	18	33	26	18	25	18	24	18	23	18	17	17
7	31	24	19	16	30	23	16	23	16	22	15	21	15	14	14
8	28	21	17	14	28	21	13	20	13	19	12	19	13	12	12
9	26	19	14	12	26	19	11	18	11	17	11	17	11	10	10
10	24	17	13	10	24	17	10	13	10	13	10	15	10	9	9

Go to www.focalpointlights.com for additional photometric data.

Numbers indicate percentage values of utilization.

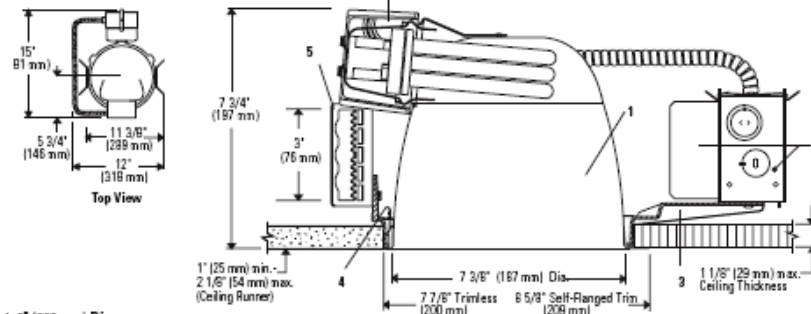
TYPE: C2

LIGHTOLIER®

Calculite® CFL Open Downlight **8037**

Page 1 of 2

7 3/8" Triple Tube Horizontal Lamp



Ceiling Cutout: 8" (203 mm) Dia.

Reflector Trim	Frame-In Kit
8037CLW Clear Iridescence Free, White Flange	S7126BU 7" aperture, 1 lamp 26W Triple Tube CFL (120/277V) 4-Pin (Amalgam)
8037CLP Clear Iridescence Free, Polished Flange	S7132BU 7" aperture, 1 lamp 26/32W Triple Tube CFL (120/277V) 4-Pin (Amalgam)
8037CL Clear Iridescence Free, Molded Trim Ring	S7142BU 7" aperture, 1 lamp 26/32/42W Triple Tube CFL (120/277V) 4-Pin (Amalgam)
8037 <input type="checkbox"/> Add suffix. See options for other finishes.	Dimming Options: S7132B <input type="checkbox"/> or S7142B <input type="checkbox"/> CU3 Lightolier PowerSpec 3% Dimming (120/277V) J1LD3 Lutron 5% Dimming (120V) J2LD3 Lutron 5% Dimming (277V) JUM7 Mark 7 Dimming (120/277V) J1MX Mark 10 Dimming (120V) J2MX Mark 10 Dimming (277V) Other dimming product available, please consult factory
	Remodeler Frame-In Kits
	7126BURM 7" aperture, 1 lamp 26W Triple Tube CFL (120/277V) 4-Pin (Amalgam)
	7132BURM 7" aperture, 1 lamp 26/32W Triple Tube CFL (120/277V) 4-Pin (Amalgam)
	7142BURM 7" aperture, 1 lamp 26/32/42W Triple Tube CFL (120/277V) 4-Pin (Amalgam)

Features

- Reflector:** 16 ga. Alzak® aluminum, 55° visual cutoff to lamp and lamp image, wide distribution. Iridescence Free finish. Self-flanged or flangeless with molded white trim ring (field paintable).
- Socket Cup:** Snaps onto reflector neck to assure consistently correct optical alignment without tools.
- Retaining Springs:** Precision-tooled steel friction springs secure reflector to mounting frame for quick, tool-less installation.
- Mounting Brackets:** 16 ga. steel. Adjust from inside of fixture. Use 3/4" or 1 1/2" lathing channel, 1/2" EMT, or optional mounting bars.
- Ballast/J-Box:** Outboard mounted to reduce heat transfer and maintain lamp efficacy and life. Service from below without tools.

Electrical

Note: Note: For ballast electrical data and latest lamp/ballast compatibility refer to "Ballast" specification sheet for complete electrical data.

UL Listed for through branch circuit wiring with max of (8) No 12 AWG, 90 degree C supply conductors.

Options and Accessories

Comfort Clear™ Finishes¹	Other Finishes
Clear CCL	White WH
Diffuse CCD	Multigroove MG
Champagne Bronze CCZ	

¹Specify desired flange
W White, **P** Polished
 Blank - Molded Ring

Options and Accessories (continued)

- | | |
|--|-----------------------|
| Emergency | Add suffix EM* |
| Chicago Plenum | Add suffix LC |
| Existing/Thk. Ceiling | FA EC7* |
| Emergency Ltg. Kit | FA EM3E* |
| | FA EM4E* |
| Fuse (Slow Blow) | Add Suffix F |
| *See Spec. Sheets: FAEC, FAEM | |
| Mounting Bars & Accessories; see Specification Sheet MBA | |
| Sloped Ceiling Adapters; see Specification Sheet SCA. | |

Labels

UL listed for damp locations, I.B.E.W.

Alzak® is a registered trademark of ALCOA

Job Information	Type:
Job Name:	
Cat. No.:	
Lamp(s):	
Notes:	

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Lightolier is a Philips group brand



TYPE: C2

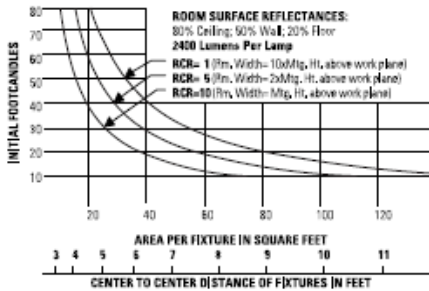
LIGHTOLIER®

Calculite® CFL Open Downlight **8037**

Page 2 of 2

7 3/8" Triple Tube Horizontal Lamp

32W Quick Calculator



This quick calculator chart determines the number and spacing of 1 ft., 32W PL-T units with clear reflector, for any level of illumination.

Spacing Ratio = 1.3

Report No.: LRL 796-1G

PREPARED BY: LIGHTING RESEARCH LABORATORY, INC

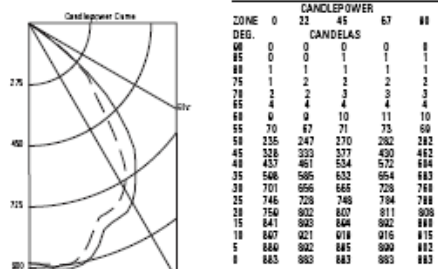
PREPARED FOR: LIGHTOLIER

DESCRIP: 7-3/8" dia. x 7" Ht. recessed downlight

- open bottom spun semispherical reflector; tilted horizontal lamp

BALLAST: LIGHTOLIER GLT423-120L

LAMPS: 1 PLT-32W rated at 2400 LUMENS.



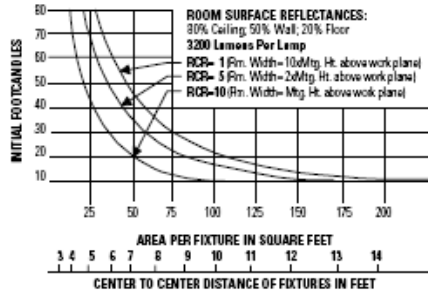
** EFFICIENCY = 61.2% **

Coefficients of Utilization

ROOM CAVITY RATIO	% EFFECTIVE CEILING CAVITY REFLECTANCE															
	80		70		50		30		10		0					
	50	30	10	50	30	10	50	30	10	0						
1	67	65	63	65	64	62	63	61	60	60	59	58	58	57	56	
2	61	58	55	60	57	55	58	55	54	56	54	52	54	53	51	50
3	55	52	49	55	51	49	53	50	48	51	49	47	50	48	46	45
4	51	47	44	50	46	43	49	45	43	47	45	42	46	44	42	41
5	47	42	39	46	42	39	45	41	39	44	41	39	43	40	38	37
6	43	38	35	42	38	35	41	38	35	40	37	35	39	37	34	33
7	39	35	32	38	35	32	38	34	32	37	34	31	36	34	30	29
8	36	32	29	36	32	29	35	32	29	35	31	29	34	31	29	28
9	34	30	27	33	29	27	33	29	27	32	29	26	32	29	26	25
10	31	27	25	31	27	24	31	27	24	30	27	24	30	26	24	23

20% FLOOR CAVITY REFLECTANCE

42W Quick Calculator



This quick calculator chart determines the number and spacing of 1 ft., 42W PL-T units with clear reflector, for any level of illumination.

Spacing Ratio = 1.4

Report No.: LRL 796-1F

PREPARED BY: LIGHTING RESEARCH LABORATORY, INC

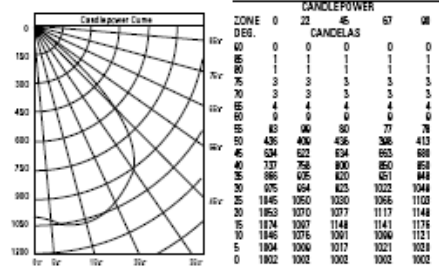
PREPARED FOR: LIGHTOLIER

DESCRIP: 7-3/8" dia. x 7" Ht. recessed downlight

- open bottom spun semispherical reflector; tilted horizontal lamp

BALLAST: LIGHTOLIER GLT423-120L

LAMPS: 1 PLT-42W rated at 3200 LUMENS.



** EFFICIENCY = 65.4% **

Coefficients of Utilization

ROOM CAVITY RATIO	% EFFECTIVE CEILING CAVITY REFLECTANCE														
	80		70		50		30		10		0				
	50	30	10	50	30	10	50	30	10	0					
1	72	70	69	71	69	68	68	67	66	65	64	64	63	62	61
2	67	64	62	66	63	61	64	62	60	62	60	58	60	58	56
3	62	59	56	61	58	56	60	57	55	58	56	54	57	55	53
4	57	54	51	57	53	50	55	52	50	54	51	49	53	50	48
5	53	49	46	53	49	46	51	48	46	50	47	45	49	47	45
6	49	45	42	49	45	42	48	44	42	47	44	41	46	43	41
7	45	41	38	45	41	38	44	40	38	43	40	37	42	40	37
8	42	37	34	41	37	34	40	37	34	40	36	34	39	36	34
9	38	34	31	38	34	31	37	33	31	36	33	30	36	33	30
10	33	29	26	33	29	26	32	28	26	32	28	25	31	28	25

20% FLOOR CAVITY REFLECTANCE

Job Information **Type:**


631 Airport Road, Fall River, MA 02720 • (508) 679-8131 • Fax (508) 674-4710
 We reserve the right to change details of design, materials and finish.
 www.lightolier.com © 2009 Philips Group • B0209

Lightolier is a Philips group brand

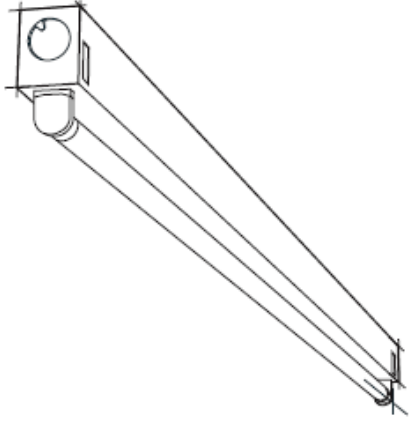


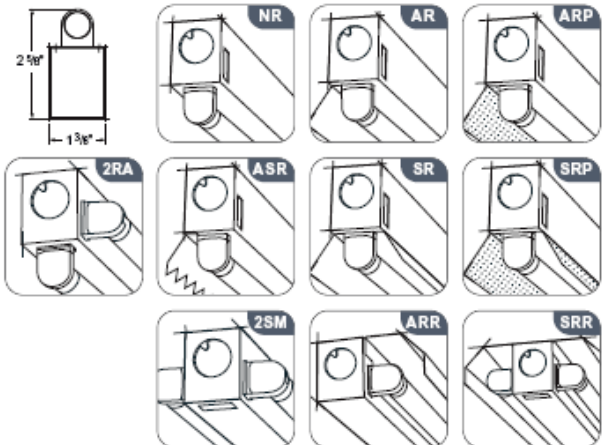
TYPE: D2

Type
Job Name
Catalog Number



String Basis Strips Series





ordering

series/ lamping	configu- ration	body style	nominal length	color/finish	circuiting	voltage	mounting	options
String-								
T5 T5HO	1TM	NR no reflector AR asymmetric reflector ARP asymmetric reflector perforated ASR asymmetric sawtooth reflector SR symmetric reflector SRP symmetric reflector perforated	02' 03' 04' 06' 08' R _— [†] †=nominal length	YGW [‡] gloss white TMW textured matte white Y _— premium color CC custom color †standard	SC DC ₅ †2 or 3 lamp only †4 minimum fixture length	120 277 UNV [†] †120-277	SUR surface or wall mount CA48* aircraft cable CA96* aircraft cable	EML [‡] EMH [‡] ECO10 [†] ECOS [†] ECOS-H [†] HI-L [†] HI-L3D [†] MRK7 [†] MRK10 [†] B _— FH EBCP1G EBCP2G <small>†4' minimum fixture lengths *not available with 35W †specify 120 or 277 voltage</small>
	1SM 2RA	NR no reflector ARR asymmetric reverse reflector						
	2SM 3SM	NR no reflector SRR symmetric reverse reflector						

Applications Retail, creative office spaces, concealed coves, schools.

Features A high-quality T5 and T5HO configurable strip fixture with a wide variety of lampping positions and reflector options. The fixture body has a minimal profile, yet integrates many common ballasts, dimming ballasts and emergency ballasts. Fixture body has side and end knockouts to accommodate top and side lamp sockets and electrical fittings.

Construction The fixture body is formed and welded of die-formed 20-gauge steel. Standard fixture nominal lengths are 2', 3', 4', 6' and 8'.

Prudential reserves the right to change design specifications or materials without notice.



Mounting Fixture is to be surface-mounted, wall-mounted directly, or suspended with adjustable aircraft cables.

Options EML: emergency battery (390-700 lumens); EMH: emergency battery (600-1325 lumens); ECO10: Lutron Eco10; ECOS: Lutron EcoSystem dimming; ECOS-H: Lutron EcoSystem H-Series dimming; HI-L: Lutron HI-Lume; HI-L3D: Lutron HI-Lume 3D; MRK7: Advance Mark7 0-10V dimming; MRK10: Advance Mark10 line voltage dimming; B_—: specific ballast, specify manufacturer and catalog number; FH: fixture fusing (slow blow); EBCP: electrical box cover plate/mud ring, single gang or 2 gang.

0816

Prudential Ltg. 1737 East 22nd Street, Los Angeles, CA 90056 10/11

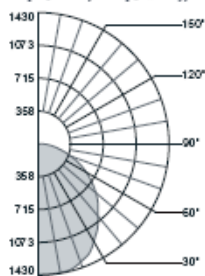
TYPE: D2

Basis Strips Series String

photometric data

STRING-2SM-SRR-04-YGW-120
Report # L0802004 D-74.4% I-15.9%
Spacing Criteria Along L&F: Across L&F
Lamp Lumen: 1500 Input Watts: 55.68



Vertical Angle	0°	22.5°	45°	67.5°	90°
0	1421	1421	1421	1421	1421
5	1411	1414	1417	1423	1430
15	1399	1373	1392	1407	1420
25	1262	1289	1319	1324	1324
35	1124	1162	1167	1146	1141
45	991	991	958	941	938
55	752	770	735	727	730
65	630	625	613	611	606
75	207	202	216	216	219
85	63	82	104	120	126
90	22	34	54	69	75
95	17	16	27	39	43
105	0	0	0	0	0
115	0	0	0	0	0
125	0	0	0	0	0
135	0	0	0	0	0
145	0	0	0	0	0
155	0	0	0	0	0
165	0	0	0	0	0
175	0	0	0	0	0
180	0	0	0	0	0

Zonal Lumen Summary

Zone	% Lamp	% Luminaires
0-90	72.30	90.10
90-180	00.60	00.00

Efficiency - 71.90%

Luminaire Summary (cd/m²)

Angle	0°	45°	90°
45	0784	0618	0215
55	0617	0856	0566
65	0070	0161	7508
75	8233	6766	6580
85	4091	5947	6801

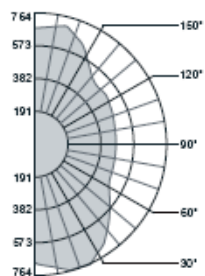
Coefficients of Utilization (%)

Floor	effective floor cavity reflectance - .20
Ceiling	80
Wall	70
70 60 30 10	70 60 30 10 60 30 10

CCR: 0 87 87 87 87 85 85 85 85 81 81 81
1 77 73 69 66 75 71 68 65 68 66 62
2 69 62 57 52 67 61 56 51 58 54 50
3 63 54 47 42 61 53 46 41 50 45 41
4 57 47 40 35 55 46 39 34 44 38 34
5 52 42 34 29 50 41 34 29 39 33 28
6 48 37 30 25 46 36 30 25 35 29 24
7 44 33 26 22 43 33 26 21 31 25 21
8 41 30 23 19 39 30 23 19 28 23 19
9 38 27 21 17 37 27 21 17 26 20 16
10 36 25 19 15 34 25 19 15 24 18 15

photometric data

STRING-2SM-NR-04-YGW
Report # L0001404 D-86.0% I-15.9%
Lamp Lumen: 1500 Input Watts: 64.13



Vertical Angle	0°	22.5°	45°	67.5°	90°
0	689	689	689	689	689
5	686	688	693	700	704
15	669	676	711	741	755
25	606	648	717	754	764
35	530	600	660	690	698
45	437	533	577	602	612
55	332	426	472	514	530
65	220	306	374	446	475
75	110	212	320	435	473
85	24	122	316	427	467
90	16	149	314	429	470
95	44	161	319	431	471
105	138	211	337	438	475
115	247	269	372	455	486
125	354	380	395	473	500
135	453	492	468	471	493
145	538	548	571	555	550
155	605	642	690	651	647
165	663	687	693	710	712
175	676	678	677	679	681
180	676	676	676	676	676

Zonal Lumen Summary

Zone	% Lamp	% Luminaires
0-90	49.20	51.90
90-180	46.30	48.90

Efficiency - 95.90%

Luminaire Summary (cd/m²)

Angle	0°	45°	90°
45	6123	6017	5851
55	5651	5415	5450
65	4960	4934	5497
75	3845	5297	6392
85	2001	6789	7941

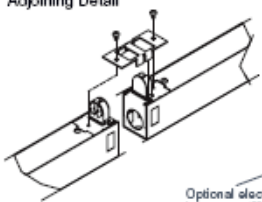
Coefficients of Utilization (%)

Floor	effective floor cavity reflectance - .20
Ceiling	80
Wall	70
70 60 30 10	70 60 30 10 60 30 10

CCR: 0 103 103 103 103 95 96 96 95 80 80 80
1 90 84 79 75 83 78 73 69 65 62 59
2 81 72 65 29 74 66 60 54 55 51 46
3 73 62 54 48 67 57 50 44 48 42 38
4 66 55 46 39 61 50 43 37 42 36 31
5 61 48 40 33 55 44 37 31 37 31 26
6 56 43 34 28 51 40 32 26 33 27 22
7 51 38 30 24 47 35 28 23 30 24 19
8 47 35 27 21 45 32 25 20 27 21 17
9 44 31 24 19 40 29 22 17 25 19 15
10 41 20 21 16 38 27 20 15 22 17 13

installation

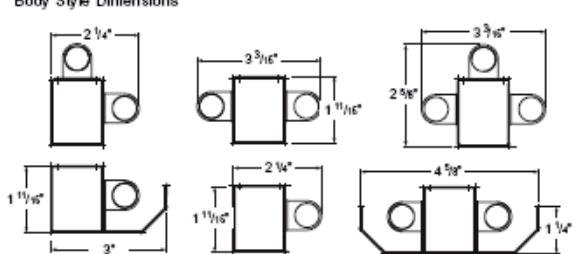
Adjoining Detail



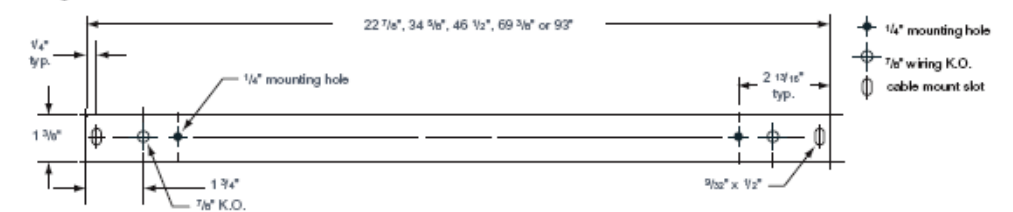
EBCP: Electrical box cover plate/mud ring single gang or 2 gang

Optional electrical box cover (2' x 4' or 4' x 4')

Body Style Dimensions



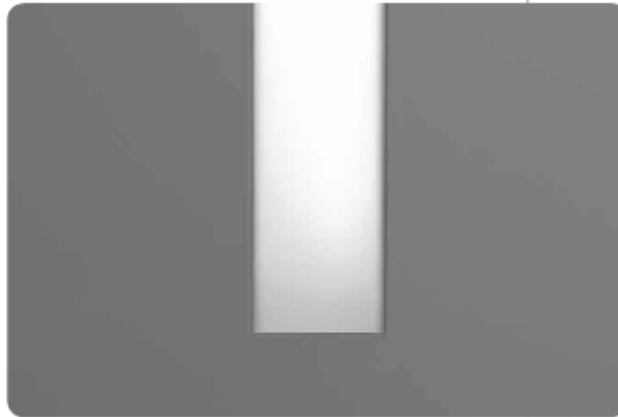
Mounting Locations



Prudential Ltg. tel 213.746.0360 fax 213.741.8590 prulite.com **0816**

TYPE: A3

recessed wall mount
seem® 4



features

Narrow 4" aperture slot fluorescent luminaire that integrates with wall for a clean unobtrusive aesthetic.

Frosted acrylic flush lens provides even illumination.

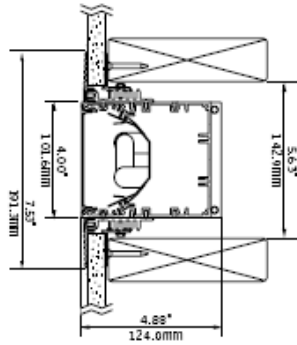
Allows for individual and continuous row mount in trimless drywall applications.

Available in 1 lamp T5 or T8 configurations, Seem 4 provides continuous illumination by combining 3' and 4' staggered lamps.

companion luminaires



dimensional data

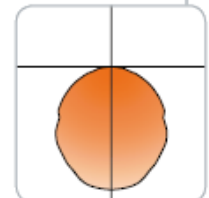


notes: designed for 2"x6" construction
0.375"min - 2.125"max material thickness

September 2011 G

performance

1-Lamp T5
56% Efficiency
595 cd @ 0'

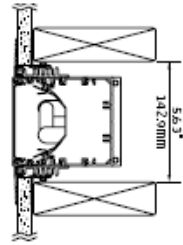


Visit focalpointlights.com for complete photometric data.

TYPE: A3

fixture:
project:

mounting information



notes: designed for 2 1/2\"/>

specifications

construction

One piece, .07\"/>

1-lamp T8: 4.47\"/>

2' unit weight: 18 lbs.
3' unit weight: 24 lbs.
4' unit weight: 30 lbs.
5' unit weight: 36 lbs.

optic

Reflectors fabricated of 22 Ga. steel finished in High Reflectance White powder coat.
Flush satin lens: extruded acrylic lens .07\"/>

electrical

Luminaires are pre-wired with factory installed branch circuit wiring and over-molded quick connect.
Electronic fluorescent ballasts are thermally protected and have a Class \"P\" rating.
Optional dimming ballasts available.
UL and cUL listed.

finish

Polyester powder coat applied over a 5-stage pre-treatment.

ordering

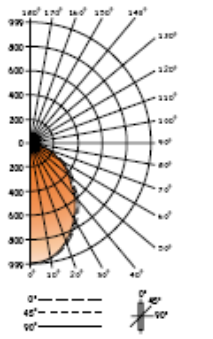
luminaire series	FSM4
Seem 4	FSM4
shielding	FL
Flush Satin Lens	FL
lamping	
One Lamp T8	1T8
One Lamp T5	1T5
circuits	1C
Single Circuit	1C
voltage	
120 Volt	120
277 Volt	277
347 Volt	347
ballast	
Electronic Instant Start <20% THD (T8 only)	E
Electronic Program Start <10% THD	S
Electronic Dimming Ballast*	D
mounting	
Mud-In Trimless, pre-set for 1/2\"/>	XF1
Mud-In Trimless, pre-set for 5/8\"/>	XF2
Mud-In Trimless, set thickness in field (mounting equipment assembled in field) (2.125\"/>	XFF
factory options	
Emergency Circuit*	EC
Emergency Battery Pack*	EM
Flex Whip*	FW
HLR/GLR Fuse	FU
Include 3000K lamp	L830
Include 3500K lamp	L835
Include 4100K lamp	L841
finish	WH
Matte White	WH
luminaire length	
(lengths are nominal)	
Specify wall and ceiling lengths in 1\"/>	X'
(lengths 6' and longer configured with staggered lamps.) (Consult factory for dimming)	

HunterDouglas.com | 1-800-368-7000 | 1-800-368-7000 | 1-800-368-7000
 For a complete list of products, visit our website at www.hunterdouglas.com

* for more information see Reference section.

TYPE: A3

seem™ 4



Spacing: 1.1
Criterion: 1.1

File Name: FSM4FLXP1TS.IES
Catalog #: FSM4-FLXP-1TS-1C-120-S-G1-WH-4"
Efficiency: 77%
Task #: 15712.0

CANDLEPOWER DISTRIBUTION

Vertical Angle	0°	22.5°	45°	67.5°	90°	Zonal Lumens
0°	999	999	999	999	999	999
5°	997	996	994	994	994	95
15°	942	941	937	93	931	266
25°	831	827	817	806	802	378
35°	692	685	670	654	648	421
45°	510	503	484	466	458	375
55°	378	373	355	338	333	319
65°	236	23	219	210	205	219
75°	118	116	111	105	103	117
85°	31	29	28	28	28	31
90°	0	0	0	0	0	0
95°	0	0	0	0	0	0
105°	0	0	0	0	0	0
115°	0	0	0	0	0	0
125°	0	0	0	0	0	0
135°	0	0	0	0	0	0
145°	0	0	0	0	0	0
155°	0	0	0	0	0	0
165°	0	0	0	0	0	0
175°	0	0	0	0	0	0
180°	0	0	0	0	0	0

LUMEN SUMMARY

Zone Lumens	% Lumens	% Footcandle		
0-30°	738	25.5	33.3	
0-40°	1159	40.0	52.2	
0-60°	1853	63.9	83.5	
0-90°	2220	76.6	100	
Total Luminaire	0-180°	2220	76.6	100

LUMINANCE DATA (CD/M²)

Vertical Angle	0°	45°	90°
45°	6091	5781	5470
55°	5566	5227	4903
65°	4716	4376	4097
75°	3850	3622	3361
85°	3004	2713	2713

CO-EFFICIENTS OF UTILIZATION

Floor	80	70	30	30	30	00										
Ceiling	70	50	30	10	70	50	10	50	10	50	10	50	10	50	10	00
Wall	70	50	30	10	70	50	10	50	10	50	10	50	10	78	78	77
RCR	91	91	91	91	89	89	89	85	85	81	81	78	78	77		
1	85	81	78	76	82	80	75	74	72	73	70	71	68	67		
2	78	72	68	64	76	71	63	68	62	66	60	64	59	58		
3	72	65	59	55	70	64	54	61	53	59	53	58	52	50		
4	66	58	52	47	65	57	47	55	46	54	46	52	45	44		
5	61	52	46	41	59	51	41	49	40	48	40	47	39	38		
6	56	47	40	36	55	46	36	45	35	44	35	42	35	33		
7	52	42	35	32	51	42	32	41	31	40	31	39	31	29		
8	48	38	32	28	47	38	28	37	27	36	27	35	27	26		
9	45	35	28	24	43	34	24	33	24	32	24	32	24	22		
10	41	31	26	22	40	31	22	30	21	30	21	29	21	20		

*Values indicate percentage utilization of fixture light.

Go to www.focalpointlights.com for additional photometric data.

seem™ 4



Spacing: 1.2
Criterion: 1.2

File Name: FSM4FL1TS.IES
Catalog #: FSM4-FL-1TS-1C-120-S-G1-WH-4"
Efficiency: 56%
Task #: 15711.0

CANDLEPOWER DISTRIBUTION

Vertical Angle	0°	22.5°	45°	67.5°	90°	Zonal Lumens
0°	595	595	595	595	595	595
5°	591	591	591	591	591	56
15°	568	568	568	568	568	161
25°	515	515	515	515	515	238
35°	455	455	455	455	455	286
45°	353	353	353	353	353	275
55°	288	288	288	288	288	289
65°	198	196	198	198	199	196
75°	108	109	109	109	109	115
85°	28	28	28	28	29	31
90°	0	0	0	0	0	0
95°	0	0	0	0	0	0
105°	0	0	0	0	0	0
115°	0	0	0	0	0	0
125°	0	0	0	0	0	0
135°	0	0	0	0	0	0
145°	0	0	0	0	0	0
155°	0	0	0	0	0	0
165°	0	0	0	0	0	0
175°	0	0	0	0	0	0
180°	0	0	0	0	0	0

LUMEN SUMMARY

Zone Lumens	% Lumens	% Footcandle		
0-30°	456	15.7	28.2	
0-40°	742	25.6	45.9	
0-60°	1275	44.0	78.9	
0-90°	1617	55.8	100	
Total Luminaire	0-180°	1617	55.8	100

LUMINANCE DATA (CD/M²)

Vertical Angle	0°	45°	90°
45°	4216	4240	4240
55°	4241	4241	4270
65°	3957	3957	3977
75°	3524	3557	3557
85°	2713	2713	2810

CO-EFFICIENTS OF UTILIZATION

Floor	80	70	30	30	30	00										
Ceiling	70	50	30	10	50	10	50	10	50	10	50	10	50	10	00	
Wall	70	50	30	10	70	50	10	50	10	50	10	50	10	56		
RCR	66	66	66	66	65	65	65	62	62	59	59	57	57	56		
1	61	59	56	54	60	57	53	55	52	53	50	51	49	48		
2	56	52	48	45	54	51	44	49	43	47	42	45	41	40		
3	51	46	41	38	50	45	38	43	37	42	36	40	36	35		
4	47	41	36	32	46	40	32	39	32	37	31	36	31	30		
5	43	36	31	27	42	35	27	34	27	33	27	32	26	25		
6	40	32	27	24	39	32	24	31	23	30	23	29	23	22		
7	36	29	24	21	36	29	21	28	21	27	20	26	20	19		
8	34	26	21	18	33	26	18	25	18	24	18	24	18	17		
9	31	23	19	16	30	23	16	22	15	22	15	21	15	14		
10	29	21	17	14	28	21	14	20	14	20	14	19	14	13		

*Values indicate percentage utilization of fixture light.

Go to www.focalpointlights.com for additional photometric data.

TYPE: A3

seem® 4 & 6 run information

EXAMPLE 16' run



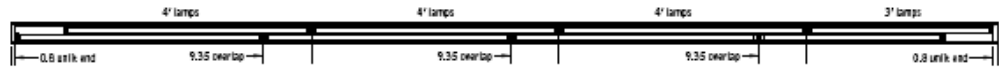
1-T5/T5HO



2-T5/T5HO (may exhibit noticeable socket shadows)



1-T8



2-T8 (may exhibit noticeable socket shadows)

notes:

- lamp overlap is consistent throughout run.
- unit ends vary to provide even light throughout run.
- standard configurations listed, consult factory for additional options.

TYPE: A3

seem® 4 & 6 run information

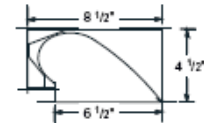
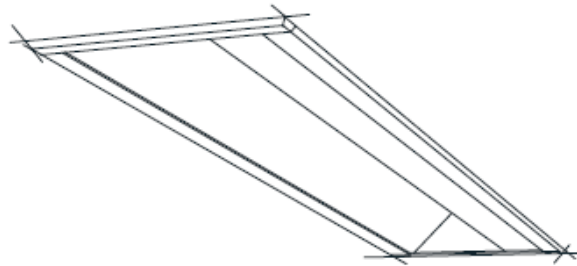
nominal run length (ft)	1-T5/T5H0 (4.35" overlap)			2-T5/T5H0 (2.00" overlap)			1-T8 (4.47" overlap)			2-T8 (9.35" overlap)		
	lamp quantity		unlit ends (no)	lamp quantity		unlit ends (no)	lamp quantity		unlit ends (no)	lamp quantity		unlit ends (no)
	3'	4'		3'	4'		3'	4'		3'	4'	
6	2		3.5	4		0.2	2		1.8	n/a	n/a	n/a
7	1	1	3.6	2	2	0.3	1	1	1.8	4		0.8
8	3		0.5		4	0.4		2	1.8	2	2	0.8
9	2	1	0.6	6		1.1	3		4.0		4	0.9
10	1	2	0.6	4	2	1.2	2	1	4.1	6		0.8
11		3	0.8	2	4	1.3	4		0.3	4	2	0.8
12	3	1	3.7		6	1.3	3	1	0.3	2	4	0.8
13	5		0.7	6	2	2.1	2	2	0.3		6	0.8
14	4	1	0.8	4	4	2.2	1	3	0.3	6	2	0.8
15	3	2	0.8	2	6	2.3		4	0.3	4	4	0.8
16	2	3	1.0		8	2.3	3	2	2.6	2	6	0.8
17	1	4	1.1	6	4	3.0	2	3	2.6		8	0.8
18		5	1.1	4	6	3.1	1	4	2.6	6	4	0.8
19	6	1	0.8	2	8	3.2	7		1.0	4	6	0.8
20	5	2	0.8		10	3.3	6	1	1.0	2	8	0.8
21	4	3	1.0	6	6	4.0	5	2	1.1		10	0.8
22	3	4	1.1	4	8	4.1	4	3	1.1	6	6	0.8
23	9		1.1	2	10	4.2	3	4	1.1	4	8	0.8
24	1	6	0.9		12	4.3	2	5	1.1	2	10	0.8
25	7	2	1.3	6	8	4.9	1	6	1.1		12	0.8
26	6	3	1.2	18		0.3		7	1.2	6	8	0.8
27	5	4	1.3	16	2	0.3	10		1.8	4	10	0.8
28	11		1.0	14	4	0.4	9	1	1.8	2	12	0.8
29	10	1	1.1	12	6	0.6	8	2	1.8		14	0.8
30	9	2	1.2	10	8	0.7	7	3	1.8	6	10	0.8
31	8	3	1.3		16	0.2	6	4	1.8	4	12	0.8
32	7	4	1.4	6	12	0.8	5	5	1.8	2	14	0.8
33	13		1.2	4	14	0.9	4	6	1.8		16	0.8
34	12	1	1.2	2	16	1.1	3	7	1.9	6	12	0.8
35	11	2	1.3		18	1.1	2	8	1.9	4	14	0.8
36	10	3	1.4	6	14	1.8	1	9	1.9	2	16	0.8
37	9	4	1.5	4	16	1.9	7	5	0.3		18	0.9
38	15		1.3	2	18	2.0	6	6	0.3	6	14	0.8
39	14	1	1.3		20	2.1	5	7	0.4	4	16	0.8
40	13	2	1.4	6	16	2.8	4	8	0.4	2	18	0.8
41	12	3	1.6	4	18	2.8	3	9	0.4		20	0.9
42	4	11	1.7	2	20	2.9	2	10	0.4	6	16	0.8
43	5	10	1.8		22	3.1	1	11	0.4	4	18	0.9
44	9	6	1.9	6	18	3.7		12	0.4	2	20	0.9
45	8	7	1.9	4	20	3.8	3	10	2.7		22	0.9
46	7	8	2.1	2	22	3.9	2	11	2.7	6	18	0.9
47	13	4	1.8		24	4.0	1	12	2.7	4	20	0.9
48	19		1.5	6	20	4.6	7	8	1.1	2	22	0.9

reference

TYPE: B3

Type
Job Name
Catalog Number

P5900 Wall Wash & Stack



ordering

series	lamp rows	nominal length	voltage	ceiling system	options
P5900					
	1T8	02'	120	X1 exposed T-bar	EML [‡]
	1T5	03'	277	X3B hard ceiling	EMH [‡]
	1T5HO	04'	347		DM
	1EX39w (3' only)	06'	UNV [‡]		RSE [‡]
	1EX_w [‡]	08'	‡120-277		10THD [‡]
		R_ [‡]			B_
		‡row length			FH
					INTCW

[‡] ballast, specify 40w, 50w or 55w

[‡]consult factory for fixture lengths < 4'
1T5 & bias only

Applications Retail displays, art galleries, corridors.

Features A recessed luminaire perfect for displaying art, merchandise or highlighting vertical surfaces. The specular reflector gives punch to the wall while concealing the lamp source.

Construction The housing, available in 2-, 3-, 4-, 6-, or 8 foot standard lengths, and flange trim are made of die-formed, 20-gauge steel.

Finish The standard housing and trim color is gloss white (YGW) using polyester powder paint.

Electrical T8 and bias fixtures have instant-start electronic ballasts with less than 20% THD. T5/T5HO fixtures have programmed-start electronic ballasts with less than 10% THD. Fixtures are U.L. Damp labeled and I.B.E.W. manufactured. Maximum ballast size available: 2.4" width x 1.5" height.

Mounting Fixture is recess-mounted in either exposed T-bar or hard ceiling application(s).

Options EML: emergency battery (600-700 lumens); EMH: emergency battery (1100-1400 lumens); DM: dimming (specify manufacturer, voltage and other requirements); RSE: rapid-start electronic (T8 & bias only); 10THD: ballast with < 10% total harmonic distortion (T8 & bias only); B_: specific ballasts, specify manufacturer and catalog number (consult factory); FH: fixture fusing (slow blow); INTCW: integrates with Sense™ System as whiteboard luminaire.

Prudential reserves the right to change design specifications or materials without notice.

0401

Prudential Ltg. 1737 East 22nd Street, Los Angeles, CA 90058 1/12

TYPE: B3

Wall Wash & Stack P5900

photometric data

P-6900-1BX60W-04
Report # L516379 D-acc.0% I-o.0%
Lamp Lumen: 8000 Input Watts: 98

Candlepower Summary

Vertical Angle	0°	22.5°	45°	67.5°	90°	Output Lumens
0	1543	1543	1543	1543	1543	
5	1484	1704	1727	1738	1743	84
10	1471	1711	1748	1911	2145	
15	1441	1688	2070	2413	2610	293
20	1395	1675	2408	2779	3020	
25	1324	1767	2852	3066	3079	557
30	1231	1925	2852	2989	3047	
35	1119	2024	2758	2860	2571	732
40	995	2064	2639	2298	1925	
45	872	2061	2232	1872	2011	734
50	735	1982	1635	1895	1990	
55	601	1759	1050	1895	1980	720
60	487	1517	1467	1746	1764	
65	332	1144	1346	1533	1451	599
70	225	804	1102	1175	1049	
75	136	650	733	755	681	343
80	70	445	429	631	421	
85	38	293	148	187	74	91
90	0	0	0	0	0	

Zonal Lumen Summary

Zone	% Lamp	% Luminaires
0-90	56.39	100.00
90-180	0.00	0.00

Efficiency - 96.4%

Luminance Summary (cd/m²)

Angle	0°	45°	90°
45	6925	17792	16036
55	5884	19530	19459
65	4411	17562	19355
75	2920	15932	14833
85	2448	9549	4780

Coefficients of Utilization (%)

Floor	effective floor cavity reflectance - 20
Ceiling	80
Wall	70
70 60 30 10 70 60 30 10 60 30 10 60 30 10	

Individual Fixtures on 8' Centers - P-6900-1BX60W-04 Vertical Footcandles

Average Illuminance maintained (LLF - 70)	Max FC	Max : Min	FC's 1' A.F.F.
35.7 FC	125.7	19.2 : 1	8.8

wall wash application

20' x 9' wall wash layout

Fixture mounted 1' from wall
Average Illuminance/Vertical Grid (Wall Surface)

Ceiling Systems

installation

Adjoining Detail

Mounting Locations

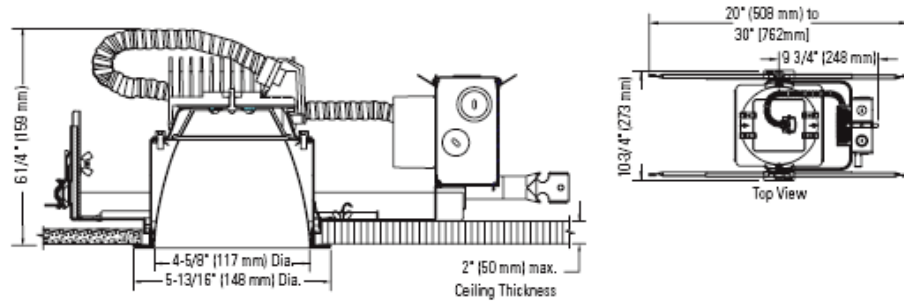
Prudential Ltg. tel 213.746.0360 fax 213.741.8590 prulite.com **0401**

TYPE: C3

C4X4L05DL

Calculite LED 4 1/2" X 4 1/2" Square Downlight

Page 1 of 6



Ordering Guide: Light Engines

Light Engine Series	Style	Color Temperature	Reflector Finish	Flange	Options
C4X4L05	DL (Downlight)	27K (2700K) 30K (3000K) 35K (3500K) 40K (4000K)	CL (Clear) CCL (Comfort Clear) CCD (Comfort Clear Diffuse) CCZ (Champagne Bronze) WH (Painted White)	W (Painted white) P (Aperture-matching/polished)	EM (Integral emergency test switch)

Example: C4L05DL35KCCCLWEM

Ordering Guide: Frame-in Kits

Frame-in Kit Series	Installation Options	Input Voltage	Options
C4X4L05	N (New construction)	1 (120V) 2 (277V) [†]	Blank (Electronic low voltage dimming) EM (Emergency) Z 10V (0-10V dimming)
CUL05	J (J-box mount retrofit) S (Screw-in base retrofit (120V only))	1 (120V) 2 (277V) [†]	Blank (Electronic low voltage dimming) Z 10V (0-10V dimming)

Example: C4L05N1EM

[†]277V dimming applications require Z10V option.

Job Information	Type:
Job Name:	
Cat. No.:	
Notes:	

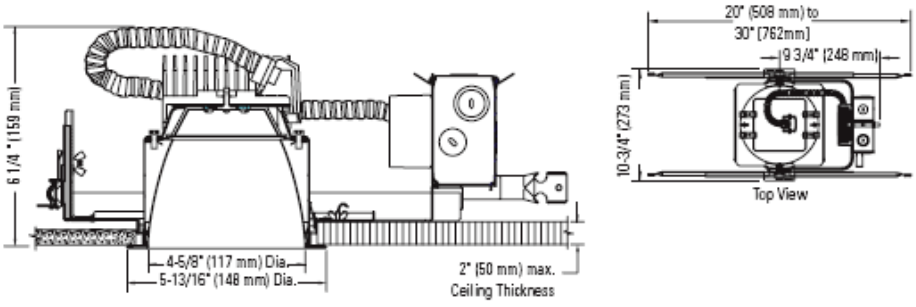
PHILIPS
LIGHTOLIER

TYPE: C3

C4X4L05DL

Calculite LED 4 1/2" X 4 1/2" Square Downlight

Page 2 of 6



Features

Aperture: 4 5/8" x 4 5/8" (117mm) I.D., 5 13/16" (148mm) O.D.

Input Wattage: 9W (+/- 5%)

Reflector Cone: Aluminum. Provides 50° cutoff to source & source image. Self-flanged.

Depth (including Frame-in kit): 5 3/4" (146mm)

Power Connection: Attaches to frame-in kit via push-in connector (on frame). Removable cover provides access.

Technology

LED Board: Array of high brightness royal blue LED's.

Remote Phosphor Technology: Remote phosphor technology provides increased efficiency and color consistency. Phosphor lens assembly positioned in front of LED array converts blue light to white. Color shift will not exceed +/- 100K over life.

Optical Mixing Chamber: Lightolier-specific mixing chamber redirects back-reflected light through aperture resulting in 20% increase in efficiency.

Thermal Management: Proprietary heat sink and thermal design along with clean room assembly ensures specified performance.

Features (continued)

Rated Life: Based on IESNA LM-80-2008 50,000 hours at 70% lumen maintenance.

Photometric Performance: Tested in accordance to IESNA LM-79-2008

Options

Dimming Capability: See LED-DIM specification sheet


Emergency Capability (Integral): Add "EM" suffix. See LED-EM spec sheet.

Emergency Capability (Inverter): See LED-LMI specification sheet

Labels

UL (suitable for wet locations), cUL, I.B.E.W.
5 Year Warranty

Job Information	Type:
------------------------	--------------



TYPE: C3

C4X4L05DL Calculite LED 4 1/2" X 4 1/2" Square Downlight

Page 3 of 6

10W LED, 2700K, CL FINISH TRIM



Distance (ft)	Beam Diameter (in)
0	320
10	320
20	320
30	320
40	320
50	320
60	320
70	320
80	320
90	320
100	320

Beam Data

Height: 0' to 10'
Width: 320" to 320"
Depth: 320" to 320"

Beam Spread Data

Height: 0' to 10'
Width: 320" to 320"
Depth: 320" to 320"

Distance (ft)	Beam Diameter (in)	Beam Area (sq ft)	Footcandle (fc)
0	320	78.5	383
10	320	78.5	383
20	320	78.5	383
30	320	78.5	383
40	320	78.5	383
50	320	78.5	383
60	320	78.5	383
70	320	78.5	383
80	320	78.5	383
90	320	78.5	383
100	320	78.5	383

TOTAL LUMENS AND PERCENTAGES

Height	Lumens	%
0.40	407	89.6%
0.60	484	100.0%
0.80	485	100.0%

CERTIFIED TEST REPORT NO. F00207

Beam Data

Height: 0' to 10'
Width: 320" to 320"
Depth: 320" to 320"

Beam Spread Data

Height: 0' to 10'
Width: 320" to 320"
Depth: 320" to 320"

Waller's Unit Data - RCR's

Height	Waller's Unit	RCR's
0' 14"	14	0.28
7' 0"	7	0.18
8' 0"	8	0.18
10'	10	0.13

3000K LED Beam, 4000lm @ 10' above floor, 3000K LED, Philips

10W LED, 2700K, CCL FINISH TRIM



Distance (ft)	Beam Diameter (in)
0	307
10	307
20	307
30	307
40	307
50	307
60	307
70	307
80	307
90	307
100	307

Beam Data

Height: 0' to 10'
Width: 307" to 307"
Depth: 307" to 307"

Beam Spread Data

Height: 0' to 10'
Width: 307" to 307"
Depth: 307" to 307"

Distance (ft)	Beam Diameter (in)	Beam Area (sq ft)	Footcandle (fc)
0	307	74.4	512
10	307	74.4	512
20	307	74.4	512
30	307	74.4	512
40	307	74.4	512
50	307	74.4	512
60	307	74.4	512
70	307	74.4	512
80	307	74.4	512
90	307	74.4	512
100	307	74.4	512

TOTAL LUMENS AND PERCENTAGES

Height	Lumens	%
0.40	393	89.6%
0.60	431	100.0%
0.80	431	100.0%

CERTIFIED TEST REPORT NO. F00207

Beam Data

Height: 0' to 10'
Width: 307" to 307"
Depth: 307" to 307"

Beam Spread Data

Height: 0' to 10'
Width: 307" to 307"
Depth: 307" to 307"

Waller's Unit Data - RCR's

Height	Waller's Unit	RCR's
0' 13"	13	0.28
7' 0"	7	0.18
8' 0"	8	0.18
10'	10	0.13

3000K LED Beam, 4000lm @ 10' above floor, 3000K LED, Philips

10W LED, 2700K, CCD FINISH TRIM



Distance (ft)	Beam Diameter (in)
0	304
10	304
20	304
30	304
40	304
50	304
60	304
70	304
80	304
90	304
100	304

Beam Data

Height: 0' to 10'
Width: 304" to 304"
Depth: 304" to 304"

Beam Spread Data

Height: 0' to 10'
Width: 304" to 304"
Depth: 304" to 304"

Distance (ft)	Beam Diameter (in)	Beam Area (sq ft)	Footcandle (fc)
0	304	72.3	528
10	304	72.3	528
20	304	72.3	528
30	304	72.3	528
40	304	72.3	528
50	304	72.3	528
60	304	72.3	528
70	304	72.3	528
80	304	72.3	528
90	304	72.3	528
100	304	72.3	528

TOTAL LUMENS AND PERCENTAGES

Height	Lumens	%
0.40	397	89.6%
0.60	438	100.0%
0.80	438	100.0%

CERTIFIED TEST REPORT NO. F00207

Beam Data

Height: 0' to 10'
Width: 304" to 304"
Depth: 304" to 304"

Beam Spread Data

Height: 0' to 10'
Width: 304" to 304"
Depth: 304" to 304"

Waller's Unit Data - RCR's

Height	Waller's Unit	RCR's
0' 12"	12	0.28
7' 0"	7	0.18
8' 0"	8	0.18
10'	10	0.13

3000K LED Beam, 4000lm @ 10' above floor, 3000K LED, Philips

Color Rendering Index (CRI) is based on a definition of 100. CRI is based on the ability of the light source to reproduce the colors of objects as they appear in natural light. The higher the CRI, the more accurately the colors will be reproduced. The CRI of this product is 90. The CRI of this product is based on the method described in the Illuminating Engineering Society (IES) Handbook, 2nd Edition, 1993. The CRI of this product is based on the method described in the Illuminating Engineering Society (IES) Handbook, 2nd Edition, 1993. The CRI of this product is based on the method described in the Illuminating Engineering Society (IES) Handbook, 2nd Edition, 1993. The CRI of this product is based on the method described in the Illuminating Engineering Society (IES) Handbook, 2nd Edition, 1993.

Job Information Type:



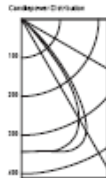
TYPE: C3

C4X4L05DL

Calulite LED 4 1/2" X 4 1/2" Square Downlight

Page 4 of 6

T0WLED, 3000K, CL FINISH TRIM



CEILING	5%	10%	15%	20%	25%	30%	35%	40%	45%
Output lumens	1	111	112	103	104	105	106	107	108
Combined Color Temp. 1	3000K	2	107	102	97	94	100	98	97
Input Watts	8.7 m	3	88	87	87	89	92	95	97
Efficiency	87.8 lm/W	6	88	75	85	74	85	78	83
CRI*	79	7	78	82	85	89	86	87	86
Spacing Criteria	1.0	14	87	85	83	86	88	89	84

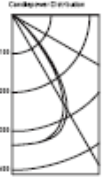
Height to Light/Floor	Beam Diameter	Beam Spacing	Spacing Criteria
0'	4" 10"	0'	1.0
1'	4" 10"	0'	1.0
2'	4" 10"	0'	1.0
3'	4" 10"	0'	1.0
4'	4" 10"	0'	1.0
5'	4" 10"	0'	1.0
6'	4" 10"	0'	1.0
7'	4" 10"	0'	1.0
8'	4" 10"	0'	1.0
9'	4" 10"	0'	1.0
10'	4" 10"	0'	1.0

Multiple Unit Data - RCP's	Spacing	Input	Output
0' 0"	10'	0.38	0.38
1' 0"	10'	0.38	0.38
2' 0"	10'	0.38	0.38
3' 0"	10'	0.38	0.38
4' 0"	10'	0.38	0.38
5' 0"	10'	0.38	0.38
6' 0"	10'	0.38	0.38
7' 0"	10'	0.38	0.38
8' 0"	10'	0.38	0.38
9' 0"	10'	0.38	0.38
10' 0"	10'	0.38	0.38

CONFIRMED TEST REPORT ID: 10274

CONFIRMED TEST REPORT ID: 10274

T0WLED, 3000K, CCD FINISH TRIM



CEILING	5%	10%	15%	20%	25%	30%	35%	40%	45%
Output lumens	1	111	110	101	102	103	104	105	106
Combined Color Temp. 1	3000K	2	108	107	101	102	102	101	102
Input Watts	8.7 m	3	88	86	85	87	90	93	96
Efficiency	86.8 lm/W	6	89	75	89	78	87	81	86
CRI*	79	7	78	82	85	89	86	87	86
Spacing Criteria	1.1	14	88	86	84	87	89	91	86

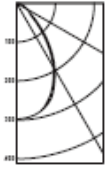
Height to Light/Floor	Beam Diameter	Beam Spacing	Spacing Criteria
0'	4" 10"	0'	1.1
1'	4" 10"	0'	1.1
2'	4" 10"	0'	1.1
3'	4" 10"	0'	1.1
4'	4" 10"	0'	1.1
5'	4" 10"	0'	1.1
6'	4" 10"	0'	1.1
7'	4" 10"	0'	1.1
8'	4" 10"	0'	1.1
9'	4" 10"	0'	1.1
10'	4" 10"	0'	1.1

Multiple Unit Data - RCP's	Spacing	Input	Output
0' 0"	10'	0.38	0.38
1' 0"	10'	0.38	0.38
2' 0"	10'	0.38	0.38
3' 0"	10'	0.38	0.38
4' 0"	10'	0.38	0.38
5' 0"	10'	0.38	0.38
6' 0"	10'	0.38	0.38
7' 0"	10'	0.38	0.38
8' 0"	10'	0.38	0.38
9' 0"	10'	0.38	0.38
10' 0"	10'	0.38	0.38

CONFIRMED TEST REPORT ID: 10274

CONFIRMED TEST REPORT ID: 10274

T0WLED, 3000K, WH FINISH TRIM



CEILING	5%	10%	15%	20%	25%	30%	35%	40%	45%
Output lumens	1	111	107	104	101	102	103	104	105
Combined Color Temp. 1	3000K	2	105	107	101	101	102	102	103
Input Watts	8.7 m	3	88	86	85	87	90	93	96
Efficiency	87.8 lm/W	6	88	75	89	78	87	81	86
CRI*	79	7	78	82	85	89	86	87	86
Spacing Criteria	1.0	14	88	86	84	87	89	91	86

Height to Light/Floor	Beam Diameter	Beam Spacing	Spacing Criteria
0'	4" 10"	0'	1.0
1'	4" 10"	0'	1.0
2'	4" 10"	0'	1.0
3'	4" 10"	0'	1.0
4'	4" 10"	0'	1.0
5'	4" 10"	0'	1.0
6'	4" 10"	0'	1.0
7'	4" 10"	0'	1.0
8'	4" 10"	0'	1.0
9'	4" 10"	0'	1.0
10'	4" 10"	0'	1.0

Multiple Unit Data - RCP's	Spacing	Input	Output
0' 0"	10'	0.38	0.38
1' 0"	10'	0.38	0.38
2' 0"	10'	0.38	0.38
3' 0"	10'	0.38	0.38
4' 0"	10'	0.38	0.38
5' 0"	10'	0.38	0.38
6' 0"	10'	0.38	0.38
7' 0"	10'	0.38	0.38
8' 0"	10'	0.38	0.38
9' 0"	10'	0.38	0.38
10' 0"	10'	0.38	0.38

CONFIRMED TEST REPORT ID: 10274

¹ Combined Color Temperature value given as defined in IESNA ANSI C92-2008: Guidelines for the Characterization of Solid State Lighting Products
² Change as needed to value IESNA
³ Based on lighting distribution as specified in IESNA LM79-2008
⁴ Adjusted according to the Illuminance and Photometric Measurement of Solid State Lighting Products
⁵ Color Rendering Index value is 100.

Job Information Type:



TYPE: C3

C4X4L05DL

Calculite LED 4 1/2" X 4 1/2" Square Downlight

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10W LED, 3500K, CL FINISH TRIM

Condition Distribution

ANGLE	FOOT	FOOT	FOOT	FOOT	FOOT
0	370	370	37		
5	368	368	36		
10	362	362	35		
15	352	352	33		
20	338	338	30		
25	320	320	27		
30	300	300	24		
35	278	278	21		
40	254	254	18		
45	228	228	15		
50	200	200	12		
55	170	170	9		
60	140	140	6		
65	110	110	3		
70	80	80	2		
75	50	50	1		
80	30	30	0		

CERAMIC	70		80		90		100		120		150		180		210		270		360		
	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	
1	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
2	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
3	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
4	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
5	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
6	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
7	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
8	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
10	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8

Height: 4 1/2" Depth: 4 1/2" Weight: 0.5 lbs

Beam Spread: 4.5" x 4.5" Mounting: Surface Mount Finish: White

Light Output: 1000 lumens Power: 10W Efficacy: 100 lm/W

Warranty: 5 years UL Listed: Yes RoHS Compliant: Yes

10W LED, 3500K, OCL FINISH TRIM

Condition Distribution

ANGLE	FOOT	FOOT	FOOT	FOOT	FOOT
0	360	360	36		
5	358	358	35		
10	352	352	34		
15	342	342	32		
20	328	328	29		
25	310	310	26		
30	290	290	23		
35	268	268	20		
40	244	244	17		
45	218	218	14		
50	190	190	11		
55	160	160	8		
60	130	130	5		
65	100	100	3		
70	70	70	2		
75	40	40	1		
80	20	20	0		

CERAMIC	70		80		90		100		120		150		180		210		270		360		
	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	
1	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105
2	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52
3	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
4	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
5	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
6	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
7	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
9	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
10	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6

Height: 4 1/2" Depth: 4 1/2" Weight: 0.5 lbs

Beam Spread: 4.5" x 4.5" Mounting: Surface Mount Finish: White

Light Output: 1000 lumens Power: 10W Efficacy: 100 lm/W

Warranty: 5 years UL Listed: Yes RoHS Compliant: Yes

10W LED, 3500K, OCC FINISH TRIM

Condition Distribution

ANGLE	FOOT	FOOT	FOOT	FOOT	FOOT
0	350	350	35		
5	348	348	34		
10	342	342	33		
15	332	332	31		
20	318	318	28		
25	298	298	25		
30	278	278	22		
35	256	256	19		
40	232	232	16		
45	208	208	13		
50	180	180	10		
55	150	150	7		
60	120	120	4		
65	90	90	3		
70	60	60	2		
75	40	40	1		
80	20	20	0		

CERAMIC	70		80		90		100		120		150		180		210		270		360		
	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	FOOT	
1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
2	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
3	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
4	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
5	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
6	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
7	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
9	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
10	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6

Height: 4 1/2" Depth: 4 1/2" Weight: 0.5 lbs

Beam Spread: 4.5" x 4.5" Mounting: Surface Mount Finish: White

Light Output: 1000 lumens Power: 10W Efficacy: 100 lm/W

Warranty: 5 years UL Listed: Yes RoHS Compliant: Yes

Job Information Type:

TYPE: C3

C4X4L05DL

Calculite LED 4 1/2" X 4 1/2" Square Downlight

Page 6 of 6

10W LED, 4000K, CL FINISH TRIM

Candela Distribution

ANGLE	0 DEG	30 DEG	30 DEG	LUMENS
0	287	287	27	
5	288	289	27	
10	291	291	27	
15	296	293	27	
20	297	294	27	
25	292	294	176	
30	234	279		
35	232	263		
40	132	152		
45	38	52		
50	4	24		
55	1	4		
60	1	1		
65	1	0		
70	0	0		
75	0	0		
80	0	0		
85	0	0		
90	0	0		

Typical: C4X4L05DL05DL05DL

Output (lumens): 572 lm

Correlated Color Temp¹⁾: 4000K

Input Watts²⁾: 0.7 w

Efficiency³⁾: 80.9 lm/w

DMF⁴⁾: 76

Spacing Criteria⁵⁾: 1.2

CEILING HGT	FOOT COUNTS	BEFORE FOOT COUNTS PERFORMANCE (%)												
		10'	11'	12'	13'	14'	15'	16'	17'	18'	19'			
0	10	119	119	119	119	119	119	119	119	119	119	119	119	119
1	112	119	119	119	119	119	119	119	119	119	119	119	119	119
2	137	102	97	94	103	92	97	91	94	99	95	98	95	98
3	131	94	89	86	92	84	90	82	88	91	94	91	94	91
4	80	87	81	78	83	75	80	73	78	81	82	76	77	77
5	90	81	76	73	83	69	79	69	76	69	76	68	68	68
6	80	75	69	66	76	63	72	63	71	63	67	61	61	61
7	80	73	67	63	73	60	69	60	68	60	68	58	58	58
8	70	65	60	56	66	54	62	53	62	53	62	52	52	52
9	71	63	58	53	63	52	60	51	60	51	60	49	49	49
10	67	67	63	48	58	48	55	48	55	48	55	48	48	48

ZONAL LUMENS AND PERCENTAGES			Height to Room			Multiple Unit Data - RCR 2		
ZONE	LUMENS	% LUMENS	Height to Room	Beam Diameter	Spacing	Beam Diameter	RCR	Beam Diameter
0-30	232	58.7%	0"	15"	0"	0"	26	0.28
0-40	510	88.9%	0"	15"	7"	0"	17	0.35
0-50	572	99.9%	7"	0"	0"	7"	12	0.18
0-60	572	100.0%	0"	0"	12"	0"	12	0.32
			0"	0"	11"	0"	8	0.12

CERTIFIED TEST REPORT NO. F08120⁶⁾

3000K/10° Beam, Waiver 2.1/2° above Foot, 83/500% Reflectances

¹⁾Correlated Color Temperature within spaces as defined in ANSI, IESNA, ANSI/IES CIE S-017-08:08 Specifications for the Colorability of Solid State Lighting Products.

²⁾Wattage controlled to within 0.5%.

³⁾Rated using standard geometry as specified in LM79-11:09 Approved Method for the Electrical and Photometric Measurements of Solid State Lighting Products.

⁴⁾Color Rendering Index, within +/- 0.2%.

Philips Lighcolier
 e: lol.webmaster@philips.com
 t: (508) 679-9131
 w: www.lighcolier.com
 C4X4L05DL November 18, 2011
 Specifications are subject to change without notice.
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Job Information **Type:**

TYPE: A4/B4

PEERLESS®



Bruno
Indirect / Direct T8

Type:

Project:

SPECIFICATIONS

Pendant Mount — Modular / 8" X 2" Rectangular

BRM4

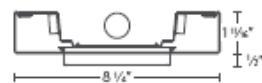
CATALOG NUMBER

FT

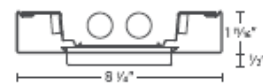
Examples: BRM4 2 32 SPR 40FT RB 277 CEB10 DCT LP835 PV16 SCEP — BRM4 3 32 SPR 32FT RB 277 CEB10 6E EL DCT LP835 PV21

AVAILABLE FIXTURES

BRM4 - 1



BRM4 - 2



BRM4 - 3



SPECIFICATIONS

Construction
Housing is a nominal 8 1/2" x 1 1/4" rectangular channel formed from cold-rolled steel. 1/8" thick aluminum die cast end cap is standard, 4" sculpted die cast aluminum end cap is optional.

Reflectors
Die formed specular reflector with 95% reflectance.

Shielding
Two choices: 1) Aluminum semispecular parabolic louver. 2) Optional white painted aluminum

parabolic baffle. Each available with optional acrylic opal overlay.

Finish
Fine textured white polyester powder paint is standard. Consult factory for special finish requirements.

Electrical
Specify 120V, 277V, or 347V. Pre-wired with 16AWG fixture wire. For special circuiting or wire

gauge, consult factory. Plug-in electrical connectors included. UL and C-UL listed and labeled.

Fixture Length
4' 1/4", 8' and 12' lengths in a single section for nominal support spacing 4'-0" and 8'-0". For total fixture length, add 1/4" for each flat end cap and 4" for each sculpted end cap. Using internal joiners, 4' and 8' sections can be joined to form longer rows. Consult factory for availability of 12' length fixture section.

ORDERING LOGIC

Use guide below to order complete fixture runs from four feet to one-hundred feet in increments of four.

Fixture	# of Lamps in Cross Section	Lamp Type	Distribution	Reflector	Shielding	Baffle	Nominal Row Length ¹	Maximum Section Length	Voltage	Ballast Type	# of Emergency Modules ²
BRM4	32	32	Blank Standard 65/35 20/80 70% Up, 80% Down 40/60 40% Up, 60% Down 0/100 0% Up, 100% Down CLI Center Lamp Isolator ³	SPR ⁴ Specular Reflector	Blank Opal Baffle w/ std brightness diffuser/ Opal overlay	SSB Semi Specular White Painted WSB Semi Specular White Painted SSP Perforated Black WSP White Painted Perforated Black	B4 B8 B12	120 277 347	CEB10 <10% THD ELECTRONIC ADEZ ⁵ Advance Mark 10 dimming ECO10 ⁶ Lutron ECO-10 dimming ADZT ⁶ Advance Mark 7 0-10v dimming	Blank No Emergency 1SE 1 section 2SE 2 sections XSE X sections	
Emergency Type ^{2,3}	Switching	Lamp Color	Mounting Type / Overall Suspension	Finish	Options						
Blank No Emergency or Night Light	SCT Single Circuit	L/LP No Lamp LP930 3000K 70+ CRI	F1 T-Bar Ceiling (Universal Mounting Brackets) F2 Hand Ceiling (Horizontal J-Box)	C20 Standard White C20A White (low textured low gloss) C10 Painted to match Aluminum Finish C099 Custom Color	ACG Adjustable Cable Grippers APF Alternate Power Feed CP Chicago Plenum DL Dump Location Label DU Dust Cover EH EM Through wire w/ Separate Feed ELS EM Through Wire w/ Single Feed GLR Fusing (Fast Blow) GNF Fusing (Slow Blow) NYC New York City Code SCEP Sculptured End Cap						
EL Emergency Battery Pack	DCD Dual Circuit	LP925 3500K 70+ CRI LP941 4100K 70+ CRI LP930 3000K 80+ CRI LP935 3500K 80+ CRI LP941 4100K 80+ CRI	F3 Stem Mount F4A IDS Clip 1/4" Tee F4B IDS Clip 1/4" Tee F4C IDS Clip Screw Slot								
EC Emergency / Night Light Circuit		Reference Lamp Chart on website or consult factory for other options.									
EH Emergency Battery Pack with Night Light Circuit											

Notes:
1 Must be in 4' increments.
2 Optional.
3 EL and EC are installed in last 4' of fixture sections and are not available concurrently with each other. Separate feed required for each EL or EC unless ELS/ELH is specified.
4 Available with standard distribution only.
5 Available with 3 lamp cross section only.
6 Not available in 347 volt.

TYPE: A4/B4

PEERLESS®

Bruno

Indirect / Direct T8

PHOTOMETRICS

Pendant Mount — Modular / 8" X 2" Rectangular

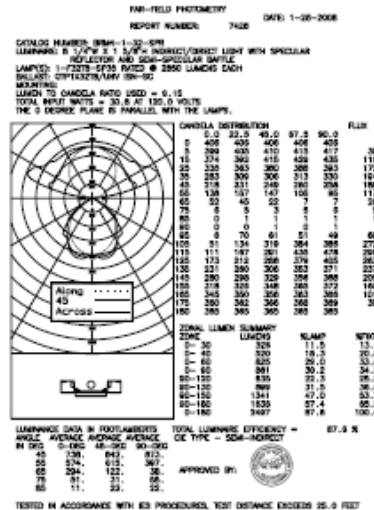
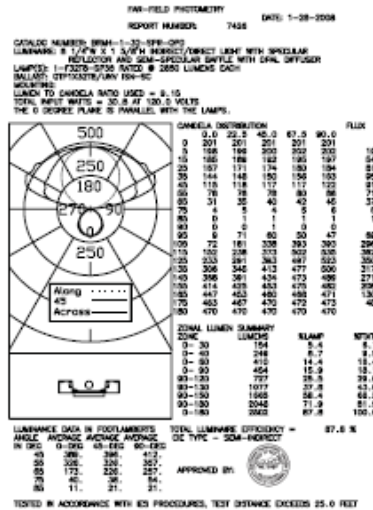
BRM4

Type:

Project:

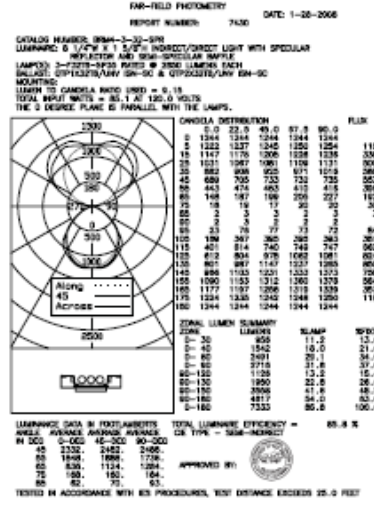
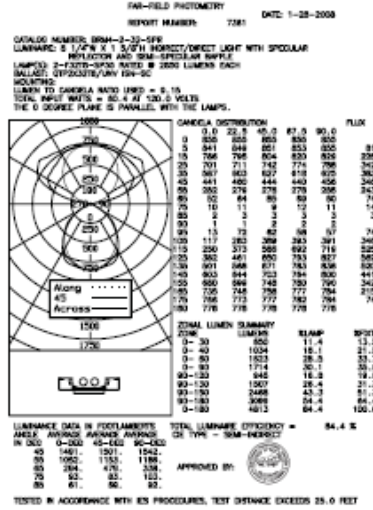
1-LAMP T8 WITH SPECULAR REFLECTOR AND OPD

1-LAMP T8 WITH SPECULAR REFLECTOR



2-LAMP T8 WITH SPECULAR REFLECTOR

3-LAMP T8 WITH SPECULAR REFLECTOR



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TYPE: A4/B4

PEERLESS®

Bruno

Indirect / Direct T8 — 40/60 VDR

PHOTOMETRICS

Pendant Mount — Modular / 8" X 2" Rectangular

BRM4

Type:

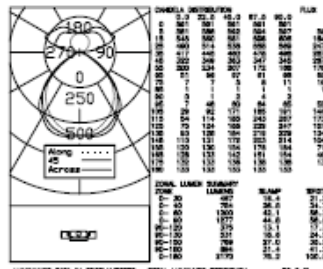
Project:

1-LAMP T8 WITH WHITE REFLECTOR

2-LAMP T8 WITH WHITE REFLECTOR

FAIR-FIELD PHOTOGRAPHY REPORT NUMBER: 7402 DATE: 3-18-2008

CATALOG NUMBER: BRM4-1-22-40-60-05/10
 LAMP/TYPE: T8 1.2" X 4' 1.2" DIMENSIONS/REFLECTOR LIGHT WITH WHITE
 LAMP/TYPE: T8 1.2" X 4' 1.2" DIMENSIONS/REFLECTOR LIGHT WITH WHITE
 REFLECTOR
 MOUNTING: HANGING
 LAMP TO CHANDELER HOOD USED = 0.15
 TOTAL HOOD DEPTH = 0.15 AT 20.0 FEET
 THE 0 DEGREE PLANE IS PARALLEL WITH THE LAMPS.



MEASURED DATA IN FOOT-CANDLES TOTAL LUMINAIRE EFFICIENCY = 78.2 %

IN 30' 0-30' 45-150' 90-200'

0-30' 45-150' 90-200'

0-30' 45-150' 90-200'

0-30' 45-150' 90-200'

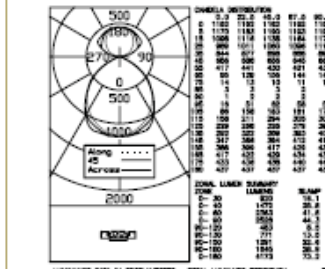
0-30' 45-150' 90-200'

APPROVED BY:

TESTED IN ACCORDANCE WITH IES PROCEDURES, TEST DISTANCE EXCEEDS 20.0 FEET

FAIR-FIELD PHOTOGRAPHY REPORT NUMBER: 7401 DATE: 3-18-2008

CATALOG NUMBER: BRM4-2-22-40-60-05/10
 LAMP/TYPE: T8 1.2" X 4' 1.2" DIMENSIONS/REFLECTOR LIGHT WITH WHITE
 LAMP/TYPE: T8 1.2" X 4' 1.2" DIMENSIONS/REFLECTOR LIGHT WITH WHITE
 REFLECTOR
 MOUNTING: HANGING
 LAMP TO CHANDELER HOOD USED = 0.15
 TOTAL HOOD DEPTH = 0.15 AT 20.0 FEET
 THE 0 DEGREE PLANE IS PARALLEL WITH THE LAMPS.



MEASURED DATA IN FOOT-CANDLES TOTAL LUMINAIRE EFFICIENCY = 73.2 %

IN 30' 0-30' 45-150' 90-200'

0-30' 45-150' 90-200'

0-30' 45-150' 90-200'

0-30' 45-150' 90-200'

0-30' 45-150' 90-200'

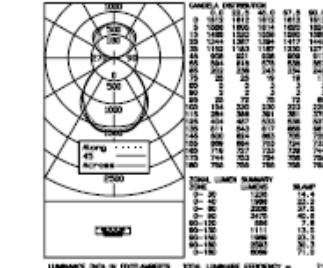
APPROVED BY:

TESTED IN ACCORDANCE WITH IES PROCEDURES, TEST DISTANCE EXCEEDS 20.0 FEET

3-LAMP T8 WITH WHITE REFLECTOR

FAIR-FIELD PHOTOGRAPHY REPORT NUMBER: 7410 DATE: 3-18-2008

CATALOG NUMBER: BRM4-3-22-40-60-05/10
 LAMP/TYPE: T8 1.2" X 4' 1.2" DIMENSIONS/REFLECTOR LIGHT WITH WHITE
 LAMP/TYPE: T8 1.2" X 4' 1.2" DIMENSIONS/REFLECTOR LIGHT WITH WHITE
 REFLECTOR
 MOUNTING: HANGING
 LAMP TO CHANDELER HOOD USED = 0.15
 TOTAL HOOD DEPTH = 0.15 AT 20.0 FEET
 THE 0 DEGREE PLANE IS PARALLEL WITH THE LAMPS.



MEASURED DATA IN FOOT-CANDLES TOTAL LUMINAIRE EFFICIENCY = 71.2 %

IN 30' 0-30' 45-150' 90-200'

0-30' 45-150' 90-200'

0-30' 45-150' 90-200'

0-30' 45-150' 90-200'

0-30' 45-150' 90-200'

APPROVED BY:

TESTED IN ACCORDANCE WITH IES PROCEDURES, TEST DISTANCE EXCEEDS 20.0 FEET

TYPE: C4

groove[™] d



features

Pendant mount decorative luminaire available with compact fluorescent or incandescent lamps

Housing, reflector and canopy are spun with high quality aluminum.

Ideally suited for retail, hospitality, lobbies, corridors, open ceiling areas and other specialty applications.

details



decorative grooves



stepped canopy & single point suspension

options



frosted green diffusion disk



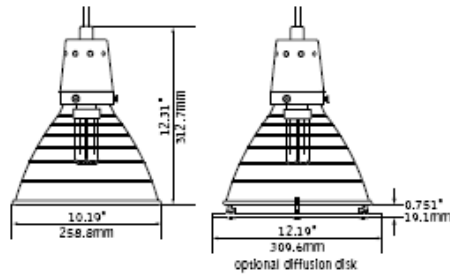
frosted white diffusion disk

companion luminaire



sconce

dimensional data



lamplng options



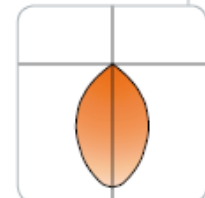
18W & 26W TRIPLE TUBE



A15, A19 & A21 LAMPS

performance

1-Lamp 26W Triple Tube
67% Efficiency
883 cd @ 0°



Visit focalpointlights.com for complete photometric data.

April 2011 B

TYPE: C4

fixtures:
project:

specifications

construction

Housing, reflector and canopy are each one-piece precision-spun 14Ga., 3002-O aluminum, (.063" min. thickness).

Housing: 5.51"H x 3.68" Dia.

Reflector: 7.59"H x 10.19" Dia. aperture with grooved cylindrical pattern.

Canopy: 1.32"H x 4.52" Dia. stepped design with #8-32 recessed sec screw.

weight: 6 lbs

optic

14Ga., 3002-O anodized aluminum reflector with diffuse satin matte surface for lamp image reduction.

Optional frosted green or white acrylic diffusion disk with polished edges are retained by aluminum fasteners and (3) #8-32 thumb screws.

electrical

Luminaires are pre-wired for single circuit with thermally protected Class "P" electronic ballast.

Factory Installed decorative metal braided power cord is included.

144" cord is provided on all luminaires and may be cut to length in field.

Incandescent:

Medium base porcelain socket.

For lamp types A15, A19 and A21, 100W max.

Fluorescent Lamp:

Single lamp triple tube compact fluorescent, 4-pin, 18W (GX24q-2) or 26W (GX24q-3).

UL and cUL listed.

finish

Luminaire housing, reflector and canopy are clear anodized with polished satin finish.

Reflector interior has matte diffuse finish.

ordering

luminaire series		<u>FGR</u>
Groove	FGR	

profile		<u>D</u>
Profile	D	

lamp quantity		<u>1</u>
One Lamp	1	

lamp type		
18W Triple Tube, GX24q-2	18TT	
26W Triple Tube, GX24q-3	26TT	
120V Only, 60W Max., A15-Med	A15	
120V Only, 100W Max., A19-Med	A19	
120V Only, 100W Max., A21-Med	A21	

ballast		
Electronic <15% THD	E	
(leave blank for Incandescent)		

voltage		
120 Volt	120	
277 Volt	277	

suspension		<u>C144</u>
Cable, Straight Feed	C144	
1.44" cable, cut in field		

factory options

Frosted Green Diffusion Disk	GD	
Frosted White Diffusion Disk	WD	

Include 3000K Lamp	L830	
--------------------	------	--

Include 3500K Lamp	L835	
--------------------	------	--



Include 4100K Lamp	L841	
(Fluorescent lamps only)		

finish		<u>NA</u>
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Natural Anodized	NA	
(contact factory for paint color options)		

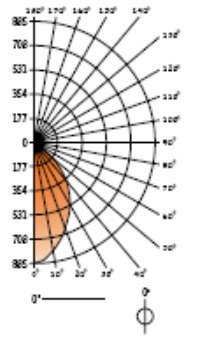
Fred Perry LLC | 1101 S. Pulaski Blvd, Chicago, IL 60607 | Tel: 773.267.2600 | Fax: 773.267.2601 | info@fredperry.com | www.fredperry.com
Local Parts: Call 1-800-828-8888 for more information on lighting products and services.

TYPE: C4

Filename: FGRD126TT.IES
 Catalog #: FGR-D-1-26TT-E-120-C144-NA
 Efficiency: 67%

CANDLEPOWER DISTRIBUTION



Vertical Angle	Horizontal Angle	Zone Lumens
0°	0°	86.5
5°	0°	86.5
15°	0°	73.3
25°	0°	58.1
35°	0°	45.4
45°	0°	29.4
55°	0°	11.2
65°	0°	2.3
75°	0°	0
85°	0°	1
90°	0°	0

Spacing 0.9
Criterion: 0.9

LUMEN SUMMARY

Zone Lumens	% Lamp	% Fix
0°-30°	561.1	31.2
0°-40°	646.3	47.0
0°-60°	1174.7	65.3
0°-90°	1266.7	67.0
Total Luminaire	0°-180°	100.0

LUMINANCE DATA (CD/M²)

Vertical Angle	0°
45°	8138
55°	3822
65°	1068
75°	454
85°	125

CO-EFFICIENTS OF UTILIZATION

	80				70				50				30				10				00			
	70	50	30	10	70	50	30	10	70	50	30	10	70	50	30	10	70	50	30	10	70	50	30	10
Wall	80	80	80	80	78	78	78	74	74	71	71	68	68	67	67	67	67	67	67	67	67	67	67	
1	75	73	71	69	74	72	68	69	66	66	64	64	62	61	61	61	61	61	61	61	61	61	61	
2	70	68	63	60	69	65	60	63	58	61	57	59	56	55	55	55	55	55	55	55	55	55	55	
3	66	60	56	53	64	59	53	58	52	56	51	54	50	49	49	49	49	49	49	49	49	49	49	
4	61	55	51	47	60	54	47	53	46	51	46	50	45	44	44	44	44	44	44	44	44	44	44	
5	57	51	46	42	56	50	42	49	42	47	41	46	41	40	40	40	40	40	40	40	40	40	40	
6	54	46	42	38	53	46	38	45	38	44	37	43	37	36	36	36	36	36	36	36	36	36	36	
7	50	43	38	35	49	42	34	41	34	41	34	40	34	33	33	33	33	33	33	33	33	33	33	
8	47	40	35	32	46	39	31	38	31	38	31	37	31	30	30	30	30	30	30	30	30	30	30	
9	45	37	32	29	44	36	29	36	29	35	29	35	29	28	28	28	28	28	28	28	28	28	28	
10	42	34	30	27	41	34	27	33	27	33	27	32	26	25	25	25	25	25	25	25	25	25	25	

Go to www.focalpointlights.com for additional photometric data.

Appendix B: electrical cut sheets

PANELBOARD

3.3 Panelboards and Lighting Control

Pow-R-Line C Panelboards

Type PRL5P



3

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Retrofit Panelboard	V2-T3-50
Type PRL3a	V2-T3-58
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Type PRL5P	
Product Description	V2-T3-78
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Product Overview

The PRL5P panelboard incorporates Eaton's plug-on power panelboard experience with modern manufacturing technology to provide the most flexible plug-on design in the industry.

Designed to eliminate the multitude of parts associated with other similar products, the PRL5P panelboard is the choice for applications where additions and changes must be fast and convenient.

Plug-On Mains and Branches provide the flexibility to move devices on factory-assembled panels after the boards are received at the job site. The electrician may move branch devices and place them into a configuration that fits the particular wiring needs of that installation.

Breakers are mounted to an adapter that includes the bus connection hardware. The breaker to bus bar connection is positive and secure. This proven connection has been utilized by Eaton in plug-on power panelboards since 1984.

Two Enclosure Widths Provide Greater Flexibility

30-Inch (762.0 mm) Wide. The narrowest enclosure in the industry for an 800A main, breaker or lug, and up to 600A branch breakers—while providing ample wiring bending space. An industry exclusive is the ability to mount two 225A, 480 Vac breakers on the same adapter unit. It requires half the space necessitated by other products.

48-Inch (1219.2 mm) Wide. Provides for mains up to 1200A. The 1200A lug adapter unit accepts up to 750 kcmil conductors. Two 600A breakers can be mounted across from one another. Another exclusive allows breakers of different sizes to be mounted across from one another, providing the ability to maximize space within the panel. There are no restrictions or predetermined spaces where branch devices must be placed.



Panelboard Installation



Type PRL5P—30-Inch (762.0 mm) Wide



Type PRL5P—48-Inch (1219.2 mm) Wide

PANELBOARD

Panelboards and Lighting Control

3.3

Pow-R-Line C Panelboards

3

Circuit Breaker and Lug Adapter Units

Breaker adapter units utilize molded case circuit breakers that provide increased performance in considerably less space than standard breakers. They're available from 15-1200A at 600 Vac maximum. A wide range of integrally mounted breaker accessories are available.

Main and through-feed lug adapter units are available and are mounted similar to the breakers. Lug units are available up to 1200A.

Breaker and lug attachment units can withstand fault currents up to 200 kA rms symmetrical.



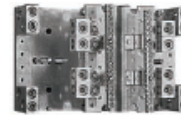
600A L-Frame Breaker



1200A Main Lug Unit



400A K-Frame Breaker



An Oversized Area is Provided for Neutral Connections with Ample Lugs for Ease of Installation



Dual-Mounted 225A F-Frame Breakers

PANELBOARD

3.3 Panelboards and Lighting Control

Pow-R-Line C Panelboards

Type PRL5P



3

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Type PRL2a	V2-T3-38
Type PRL2aF	V2-T3-42
Type PRL2a-LX	V2-T3-46
Retrofit Panelboard	V2-T3-50
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Type PRL5P	
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Product Selection	V2-T3-79
Modifications	V2-T3-82
Technical Data and Specifications	V2-T3-84
Dimensions	V2-T3-84

Type PRL5P

Product Description

- 600 Vac maximum (250 Vdc)
- Three-phase four-wire, three-phase three-wire, single-phase three-wire
- 1200A maximum mains
- 1200A maximum branch devices
- Plug-on branch devices
- Factory assembled
- Refer to Pages V2-T3-7 and V2-T3-78 for additional information

Application Description

- Power distribution panelboard
- Fully rated or series rated
- Interrupting ratings up to 200 kA symmetrical
- Suitable for use as Service Entrance Equipment, when specified on the order
- See Pages V2-T3-7 through V2-T3-23 for additional information

Standards and Certifications

- UL 67, UL 50
- Federal Specification W-P-115c
- Refer to Page V2-T3-7 for additional information



PANELBOARD

Panelboards and Lighting Control

3.3

Pow-R-Line C Panelboards

3

Product Selection

Panelboard Selection and Layout

Select either single-row or double-row bus chassis. Single-row bus chassis—maximum 800 ampere main breaker or main lug only. Select main device and "X" space from table below. Select branch devices and corresponding "X" space from the following tables.

Refer to layout data from the following tables. Make a layout sketch of the main and branch devices utilizing either a single-row or double-row bus chassis indicating the "X" space for each device. The maximum total "X" space cannot exceed 40X for any panelboard. Should more than 40X be required, add the appropriate through-feed lug adapter or breaker to feed an additional panelboard.

Type PRL5P



PRL5P

Main Ampere Rating	Interrupting Rating (kA Symmetrical)				Main Device Type	Main "X" Space
	240 Vac	480 Vac	600 Vac	250 Vdc		
Main Lug Only Single-Row Bus						
400	—	—	—	—	Lug	8X
600	—	—	—	—	Lug	8X
800	—	—	—	—	Lug	8X
Main Lug Only Double-Row Bus						
800	—	—	—	—	Lug	7X
1200	—	—	—	—	Lug	7X
Main Breaker Single-Row Bus						
400	65	—	—	10	DK	4X
400	65	35	25	10	KD	4X
400	100	65	35	22	HKD	4X
400	200	100	65	22	KDC	4X
600	35	35	25	22	LD	6X
600	100	65	35	25	HL	6X
600	200	100	35	25	LDC	6X
800	65	50	25	22	MDL	6X
800	100	65	35	25	HMDL	6X
Main Breaker Double-Row Bus						
800	65	50	25	22	MDL	6X
800	100	65	35	25	HMDL	6X
1200	65	50	25	—	ND	6X
1200	100	65	35	—	HND	6X
1200	200	100	65	—	NDC	6X

Branch Devices—Single-Pole Breakers in Single Adapter Units—PRL5P

Ampere Rating	Interrupting Rating (kA Symmetrical)				Breaker Type	"X" Type
	120 Vac	240 Vac	277 Vac	125 Vdc		
15-60	14	—	14	10	EHD	2X, 3X
15-60	35	—	35	10	FD	2X, 3X
15-60	65	—	65	10	HFD	2X, 3X

Note

Ⓢ Includes aluminum bus chassis, box, trim, main and neutral (if required).

BREAKERS

12.2 Molded Case Circuit Breakers

Series G Ground Fault (Earth Leakage) and Current Limiting Circuit Breaker Modules

30 mA Ground Fault (Earth Leakage) Modules



Clockwise from Left: JG, LG, EG MCCBs Shown with Ground Fault (Earth Leakage) Module

Contents

Description	Page
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Dimensions	4
Current Limiting Circuit Breaker Modules	6
Product Overview	6
Product Description	6
Application Description	6
Features and Benefits	6
Product Selection	7
Dimensions	8

12

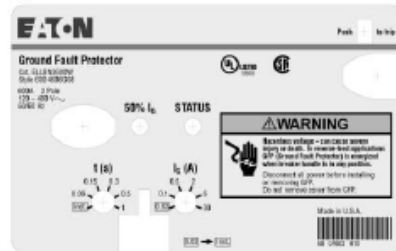
30 mA Ground Fault (Earth Leakage) Modules

Product Description

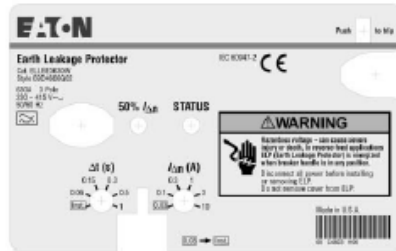
Eaton offers a three- and four-pole 30 mA ground fault (earth leakage) protection module for Series G E-, J- and L-Frame breakers. The module does not restrict the use of other breaker accessories. UL®-listed modules are available for E, J and L molded case circuit breakers (MCCBs). The modules are bottom mounted for circuits up to 125A (E-Frame) 160 and 250 amperes (J-Frame), or 400 and 630 amperes for the L-Frame.

The module is completely self-contained because the current sensor, relay and power supply are located inside the product. Current pickup settings are selectable from 0.03–10 amperes for all IEC-rated modules and E and J UL-listed module, and 0.03–30 amperes for the L UL-listed modules. Time delays are also selectable from Instantaneous–1.0 seconds for 0.10 ampere settings and above. A current pickup setting of 0.03 amperes defaults to an Instantaneous time setting regardless of the time dial's position. Two alarm contacts come as standard: a 50% pretrip and a 100% after trip, both based only on earth leakage current levels.

UL-Rated LG-Frame Earth Leakage Module Faceplate



IEC-Rated LG-Frame Earth Leakage Module Faceplate



BREAKERS

Molded Case Circuit Breakers

12.2

Series G Ground Fault (Earth Leakage) and Current Limiting Circuit Breaker Modules

Product Selection

EG-Frame



EG-Frame Ground Fault Modules, UL-Rated (Bottom Mounted, 120–480 Vac, 50/60 Hz)

Amperes	Number of Poles	Catalog Number
125	3	ELEBN3125G
125	4	ELEBN4125G

LG-Frame



LG-Frame Ground Fault Modules, UL-Rated (Bottom Mounted, 120–480 Vac, 50/60 Hz)

Amperes	Number of Poles	Catalog Number
400	3	ELLEN3400W
400	4	ELLEN4400W
600	3	ELLEN3600W
600	4	ELLEN4600W

EG-Frame Earth Leakage Modules, IEC-Rated (Bottom Mounted, 230–415 Vac, 50/60 Hz)

Amperes	Number of Poles	Catalog Number
125	3	ELEBE3125G
125	4	ELEBE4125G

LG-Frame Earth Leakage Modules, IEC-Rated (Bottom Mounted, 230–415 Vac, 50/60 Hz)

Amperes	Number of Poles	Catalog Number
400	3	ELLEB3400W
400	4	ELLEB4400W
630	3	ELLEB3630W
630	4	ELLEB4630W

JG-Frame



JG-Frame Ground Fault Modules, UL-Rated (Bottom Mounted, 120–480 Vac, 50/60 Hz)

Amperes	Number of Poles	Catalog Number
150	3	ELJBN3150W
150	4	ELJBN4150W
250	3	ELJBN3250W
250	4	ELJBN4250W

JG-Frame Earth Leakage Modules, IEC-Rated (Bottom Mounted, 230–415 Vac, 50/60 Hz)

Amperes	Number of Poles	Catalog Number
160	3	ELJBE3160W
160	4	ELJBE4160W
250	3	ELJBE3250W
250	4	ELJBE4250W

BREAKERS

12.2 Molded Case Circuit Breakers

Series G Ground Fault (Earth Leakage) and Current Limiting Circuit Breaker Modules

Dimensions

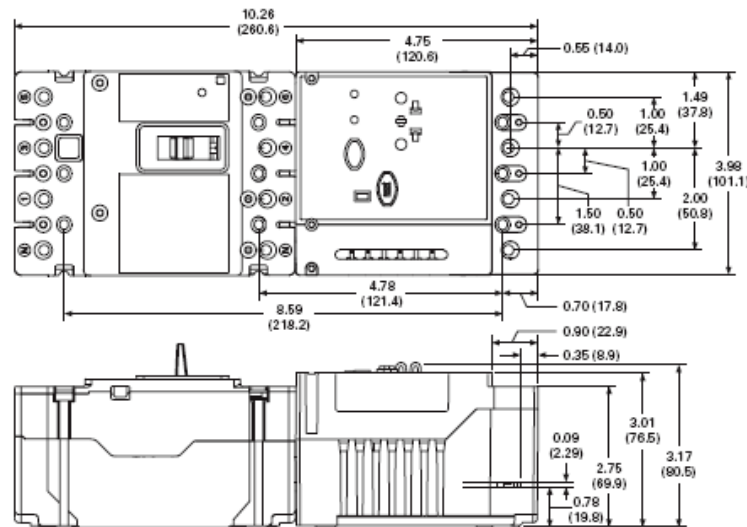
Approximate Dimensions in Inches (mm)

Assembled Breaker and Earth Leakage Module

Frame	Height	Width	Depth
Three-Pole			
EG	10.25 (260.3)	3.00 (76.2)	2.98 (75.8)
JG	11.25 (285.8)	4.13 (104.9)	3.57 (90.7)
LG	15.38 (390.7)	5.48 (139.2)	4.06 (103.1)
Four-Pole			
EG	10.25 (260.3)	4.00 (101.6)	2.98 (75.8)
JG	11.25 (285.8)	5.50 (139.7)	3.57 (90.7)
LG	15.38 (390.7)	7.23 (183.6)	4.06 (103.1)

EG-Frame With Earth Leakage Module

12

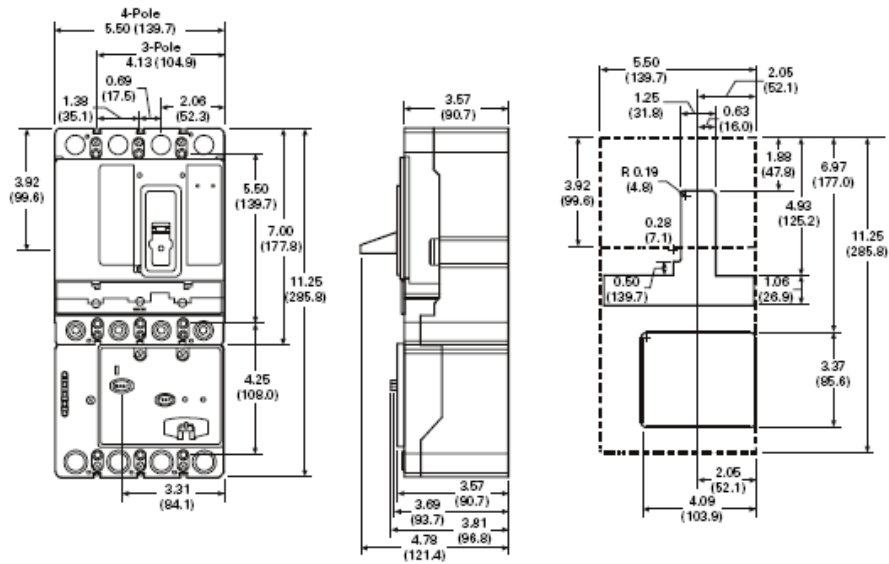


BREAKERS

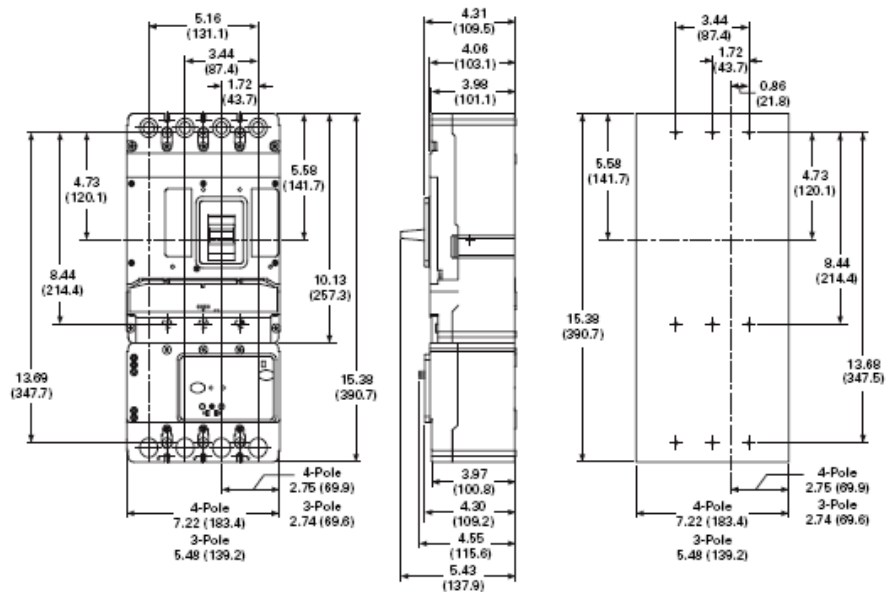
Molded Case Circuit Breakers 12.2

Series G Ground Fault (Earth Leakage) and Current Limiting Circuit Breaker Modules

JG-Frame With Earth Leakage Module



LG-Frame With Earth Leakage Module



Appendix C: control schedule and cut sheets

CONTROL PANEL



Pow-R-Command™ 3000 Lighting Power Reduction Panel Specifications and Capacities

Technical Data TD01412053E

Effective November 2008



Product Specifications

TABLE 1. VOLTAGES AND CAPACITIES

MODEL NUMBER	CAPACITY	VOLTAGE
PRC3000-60-120	60 Amps, 3-Phase	120 / 208
PRC3000-60-277	60 Amps, 3-Phase	277 / 480
PRC3000-100-120	100 Amps, 3-Phase	120 / 208
PRC3000-100-277	100 Amps, 3-Phase	277 / 480
PRC3000-200-120	200 Amps, 3-Phase	120 / 208
PRC3000-200-277	200 Amps, 3-Phase	277 / 480

TABLE 2. DIMENSIONS

MODEL NUMBER	DIMENSIONS (W X H X D) — INCHES (MM)	WEIGHT — LBS (KG)
PRC3000-60-120	11.00 x 16.75 x 12.00 (279.4 x 425.5 x 304.8)	52 (24)
PRC3000-60-277	11.00 x 16.75 x 12.00 (279.4 x 425.5 x 304.8)	52 (24)
PRC3000-100-120	27.00 x 19.00 x 9.00 (685.8 x 482.6 x 228.6)	85 (39)
PRC3000-100-277	27.00 x 19.00 x 9.00 (685.8 x 482.6 x 228.6)	85 (39)
PRC3000-200-120	27.00 x 21.00 x 12.75 (685.8 x 533.4 x 323.9)	148 (67)
PRC3000-200-277	27.00 x 21.00 x 12.75 (685.8 x 533.4 x 323.9)	148 (67)

Introduction

The Pow-R-Command 3000 Lighting Power Reduction Panel is an energy-saving device for use with new or existing fluorescent lighting systems. By conditioning the incoming power wave, it reduces electrical consumption with negligible foot-candle loss at savings up to 15%.

For safety, the Pow-R-Command 3000 Lighting Power Reduction Panel is UL® and cUL® listed.

The Pow-R-Command 3000 Lighting Power Reduction Panel drops consumption, maintains light levels and offers a great ROI.

The Pow-R-Command 3000 Lighting Power Reduction Panel must be installed by licensed electrical personnel meeting all appropriate state electrical codes.

CONTROL PANEL



Installation: Installation is accomplished by "splicing" the Pow-R-Command 3000 Lighting Power Reduction Panel in between the supply feeder and the lighting panel. The Pow-R-Command 3000 Lighting Power Reduction Panel conditions the power for all of the lights controlled by the lighting panel. Suitable for three-phase or single-phase systems.

Ballast Requirements: The Pow-R-Command 3000 Lighting Power Reduction Panel works with either T8 or T12 ballasts. Testing shows that the greatest savings with the least lumen loss are achieved when the Pow-R-Command 3000 Lighting Power Reduction Panel is used with single voltage T8 ballasts.

TABLE 3. MAXIMUM NUMBER OF FIXTURES PER POW-R-COMMAND 3000 LIGHTING POWER REDUCTION PANEL

MODEL	NUMBER OF FIXTURES (2 X 32W LAMPS)	NUMBER OF FIXTURES (4 X 32W LAMPS)	NUMBER OF FIXTURES (6 X 32W LAMPS)
PRC3000-60-120	300	150	100
PRC3000-60-277	600	345	220
PRC3000-100-120	500	250	165
PRC3000-100-277	1150	575	380
PRC3000-200-120	1000	500	330
PRC3000-200-277	2300	1150	765

Bypass: The Pow-R-Command 3000 Lighting Power Reduction Panel is equipped with an electronic bypass. It is accessible only after removing the outer cover. The cover and panel are equipped with holes for a security seal. This satisfies utility requirements for energy-saving devices by preventing use of the bypass except in the event of an equipment failure.

Enclosure: Gray powder coated, galvanized steel. Rated as NEMA® 1.

UL/cUL Listing: The Pow-R-Command 3000 Lighting Power Reduction Panel is UL and cUL listed, File Number E306255.

Generator Compatibility: The Pow-R-Command 3000 Lighting Power Reduction Panel is compatible with generators. The Pow-R-Command 3000 Lighting Power Reduction Panel adjusts to any sine wave shift caused by the transition from grid to generator or generator to grid.

Computer Connection: The Pow-R-Command 3000 Lighting Power Reduction Panel connects to any PC or laptop via a serial cable via an external RJ-45 jack located on the upper right side of the enclosure.

Control Software: The Pow-R-Command 3000 Lighting Power Reduction Panel is controlled with the Pow-R-Command 3000 software provided. This software is compatible with the Windows® family of operating systems. This software controls each phase independently and allows the user to program lighting changes as timed events and/or turn all lights associated with each of the phases on and off.

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 Electrical Group
 1000 Cherrington Parkway
 Moon Township, PA 15108
 United States
 877-ETN-CARE (877-366-2273)
 Eaton.com



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 Printed in USA
 Publication No. TD01412053E / Z751.1
 November 2008

OCCUPANCY SENSOR

COMMERCIAL OCCUPANCY SENSORS & CONTROLS

DT-355 Dual Technology Line Voltage Ceiling Sensor



Architecturally appealing, low profile appearance

Auto set automatically selects optimal settings for each space

Ultrasonic diffusers give more comprehensive coverage

Operates at 120, 277 or 347 VAC, 50/60 Hz

Terminal wiring for quick and easy installation

Walk-through mode increases savings potential

PROJECT _____

LOCATION/TYPE _____

Product Overview

Description

WattStopper's low profile DT-355 dual technology occupancy sensor combines the benefits of passive infrared (PIR) and ultrasonic technologies. The sensor mounts on the ceiling with a flat, unobtrusive appearance and provides 360 degrees of coverage.

Operation

The DT-355 is line voltage and operates at 120, 277 or 347 VAC. The sensor turns lighting on when both PIR and ultrasonic technologies detect occupancy. PIR technology senses the difference between infrared energy from a human body in motion and the background space. Ultrasonic technology uses high frequency (40KHz) ultrasound to sense motion within the space. Once lighting is on, detection by either technology holds lighting on. When no occupancy is detected for the length of the time delay, lighting turns off. The DT-355 can also be set so that only one technology is needed to trigger or both technologies are needed to hold lighting on.

Features

- Advanced control logic based on RISC micro-controller provides:
 - Detection Signature Processing eliminates false triggers and provides immunity to RFI and EMI
 - Walk-through mode turns lights off 3 minutes after the area is initially occupied – ideal for brief visits such as mail delivery
 - Built-in light level sensor featuring simple, one-step setup

Auto Set

The DT-355 requires no adjustment at installation. Auto set continuously monitors the controlled space to identify usage patterns. Using this information, it automatically adjusts the time delay and sensitivity settings for optimal performance and energy efficiency. The sensor assigns short delays (as low as 5 minutes) for times when the space is usually vacant, and longer delays (up to 30 minutes) for busier times.

Application

WattStopper's patented dual technology has the flexibility to work in a variety of applications, where one technology alone could encounter false triggers. Ideal applications include classrooms, open office spaces, large offices, and computer rooms. In addition, because the DT-355 can be mounted onto a variety of junction boxes, the sensor has the flexibility to be used in a wide range of spaces. The sensors eliminate the need for a power pack by using line voltage wiring.

- Ultrasonic diffusion technology spreads coverage to a wider area (patent pending)
- DIP switch simplifies sensor adjustments
- LEDs indicate occupancy detection
- Uses existing line voltage wiring and doesn't require a power pack
- Six occupancy logic options give users the ability to customize control to meet application needs
- Qualifies for ARRA-funded public works projects

WattStopper
www.wattstopper.com
800.879.8885

OCCUPANCY SENSOR



COMMERCIAL OCCUPANCY SENSORS & CONTROLS

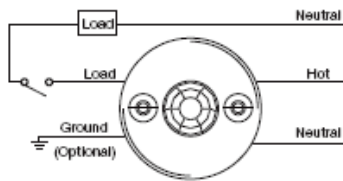
Specifications

- 120/277/347 VAC, 50/60 Hz
- Ultrasonic frequency of 40kHz
- Time delays: Auto set, fixed (5, 10, 15, 20, or 30 minutes), walk-through, test-mode
- Sensitivity adjustment: Auto set or reduced sensitivity (for PIR sensitivity); ultrasonic sensitivity is variable with trimpot
- Built-in light level sensor – works from 10 to 300 footcandles (107.6 to 3,229.2 lux)

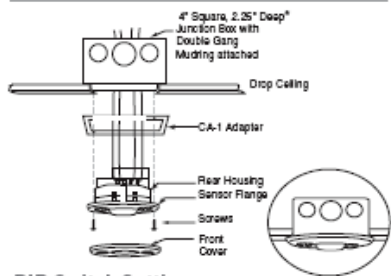
- Multi-level, 360° Fresnel lens for superior occupancy detection
- Mounting options: 4 square junction box with double gang mudding; 4 inch octagonal junction box
- Dimensions: 4.50" diameter x 1.45" deep (114.3mm x 25.9mm)
- UL and cUL listed
- Five year warranty

Wiring & Mounting

DT-355 Wiring Diagram

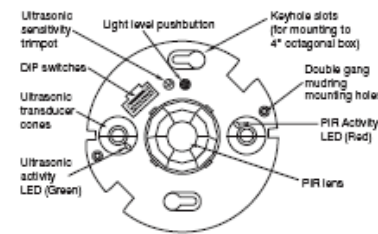


Ceiling Mounting



Controls & Settings

Product Controls



DIP Switch Settings

◀ = Factory Setting
● = ON
◻ = OFF

Logic	Switch 1	Switch 2	Switch 3
Occupancy	Standard	PIR	PIR/OC (Occupancy)
Option 1	OC	PIR	PIR/OC
Option 2	OC	PIR	PIR/OC
Option 3	OC	PIR	PIR/OC
Option 4	OC	PIR	PIR/OC
Option 5	OC	PIR	PIR/OC
Option 6	OC	PIR	PIR/OC
Option 7	OC	PIR	PIR/OC

Occupancy Logic	PIR	OC	PIR/OC
Standard	Off	Off	On
Option 1	On	Off	Off
Option 2	On	Off	Off
Option 3	On	Off	Off
Option 4	On	Off	Off
Option 5	On	Off	Off
Option 6	On	Off	Off
Option 7	On	Off	Off

Time Delay	4	5	6
5 sec/SmartSet	Off	Off	On
5 minutes	On	Off	Off
10 min. A	On	Off	Off
10 minutes	On	Off	Off
15 min. B	On	Off	Off
15 minutes	On	Off	Off
20 minutes	On	Off	Off
30 min. C	On	Off	Off

↑ Walk through mode

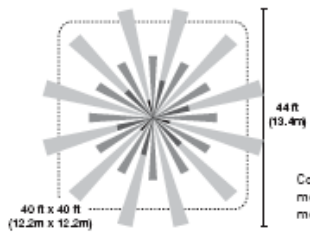
LEDs	7
Disabled	On
Enabled	Off

PIR Sensitivity	8
Minimum	On
Max./SmartSet	Off

The technology control (occupancy logic) options are adjustable by user. The standard setting (recommended for most applications) is both technologies to trigger on, either to hold on.

Coverage

Coverage Pattern



Coverage shown is maximum and represents half-step walking motion. Under ideal conditions, coverage for half-step walking motion can reach up to 1000 ft² (92.9 m²).

Ordering Information

Catalog No.	Voltage	Load Rating	Coverage
<input type="checkbox"/> DT-355	120 VAC, 50/60 Hz	0-800W Ballast/Tungsten	up to 1000 ft² (92.9 m²)
<input type="checkbox"/> DT-355-U	277 VAC, 50/60 Hz	0-1200W Ballast	
<input type="checkbox"/> DT-355-U	347 VAC, 50/60 Hz	0-1500W Ballast	
<input type="checkbox"/> CA-1	Cosmetic adaptor for ceiling installations with 4" square j-box or Wiremold #V5748-2 box		

Sensors are white.

Appendix D: lighting plans