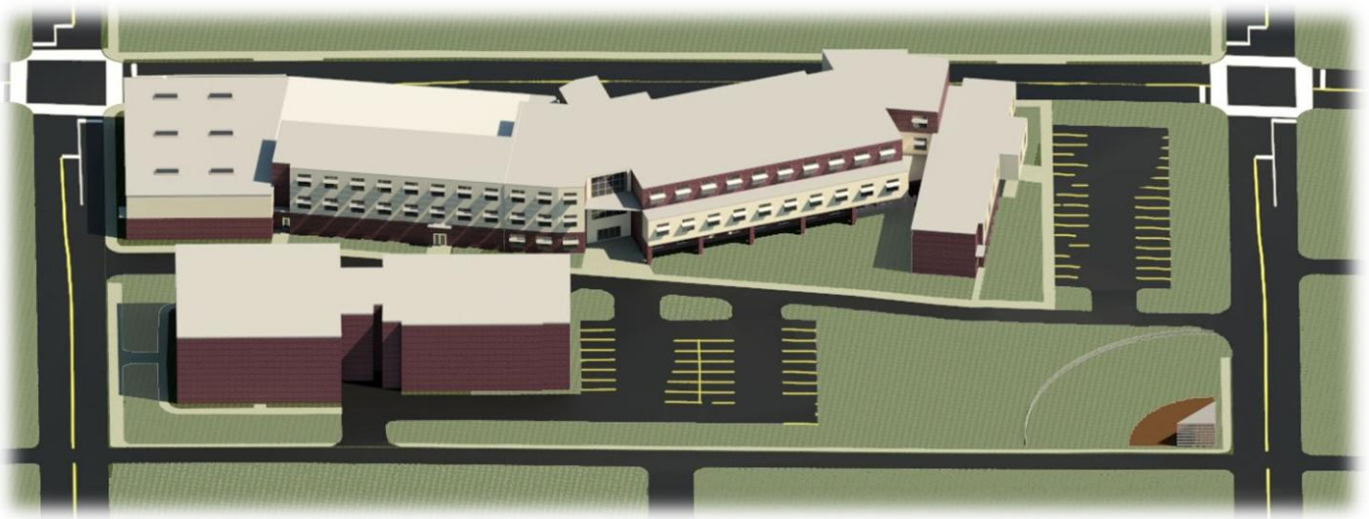


22 February 2013

2013 ASCE Charles Pankow Foundation
Annual Architectural Engineering Student Competition



LIGHTING/ELECTRICAL REPORT



Team Registration Number: 02-2013

Table of Contents

1. Executive Summary.....2
 1.1. Owner Goals3
 1.2. Nexus Goals3
 1.3. Lighting Goals4

2. Experience.....5
 2.1 Campus5
 2.2 Lobby5
 2.3 Lobby Rationale6

3. Community.....6
 3.1 Multipurpose Room.....6
 3.2 Multipurpose Room Rationale7
 3.3 Pool.....8
 3.4 Pool Rationale.....8

4. Education10
 4.1 Classroom10
 4.2 Classroom Rationale11

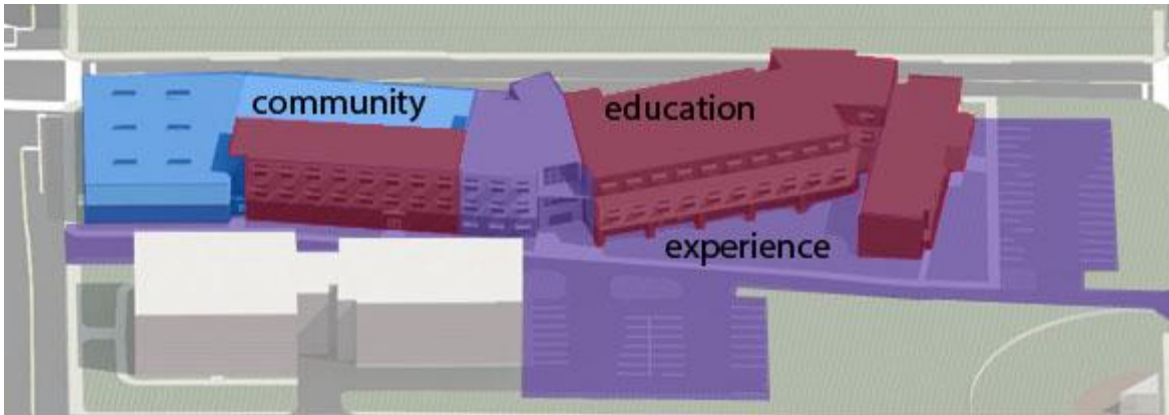
5. Conclusion.....12

6. Supporting Documentation13
 6.1 Lobby: AGI32 Calculation and Switching Diagram 13
 6.2 Multipurpose Room: Emergency Lighting Calculation 14
 6.3 Multipurpose Room: Switching Diagram 15
 6.4 Pool: AGI32 Calculations 16
 6.4.1 Daylight Only (Clear Sky)..... 16
 6.4.2 Combined Electric Lighting and Daylight (Clear Sky) 17
 6.4.3 Combined Electric Lighting and Daylight (Cloudy) 18
 6.4.4 Combined with Electric Light at Half-Output (Clear Sky)..... 19
 6.5 Pool: AGI32 Calculation of Emergency Lighting 20
 6.6 Pool: Switching/Wiring Diagrams 21
 6.7 Classroom Daylight Analysis 22
 6.7.1 Noon, Clear Sky 22
 6.7.2 Noon, Cloudy 23
 6.7.3 Morning, Clear Sky..... 24
 6.7.4 Morning, Cloudy 25
 6.7.5 Afternoon, Clear Sky 26
 6.7.6 Afternoon, Cloudy 27
 6.8 Classroom: Electric Lighting Calculation and Wiring Diagram..... 28
 6.9 Panel Board Schedules 29

7. Drawings33

1. Executive Summary

In considering the socioeconomics of Reading, Pennsylvania and the necessity for a new elementary school, it was determined that the building will be broken into three distinct categories that merge together to create a school that benefits both the students and the community. These three categories are: **Experience**, **Community**, and **Education**.



The **Experience** category of the building consists of the campus, the building envelope, and the lobby of the school. It is also the intersection of the Education and Community sections. One major goal for the Experience section is to make the students and the visitors feel welcome when they visit the school. The lighting in this part of the school is meant to create a pleasant, welcoming feeling. The use of three glowing rings in the triple height lobby emphasizes the verticality of the space, while creating an aesthetically pleasing arrangement. Safety is heavily emphasized in the Experience area of the building by providing enough light for facial recognition at night, as well as keeping the area bright enough to deter criminal activity.

The **Community** category consists of the gymnasium and the pool. The gymnasium is reserved for the students during school hours, but will be open to the community in the evening. The lighting of the gym needs to be versatile to be able to adapt to the needs of the client and to the activities in the space. The pool is an add-option package that the school system can choose to build if and when the funds are available. Nexus included the pool as a way to give back to the community. Special care needs to be taken in the pool area to ensure that there is minimal glare on the surface of the pool to create a safe environment for swimmers.

The **Education** category is the heart of the school. This section is where the classrooms and learning spaces are located. With the classrooms came the need to integrate daylighting into the overall design of the building. The lighting and structural teams integrated the systems to ensure adequate daylight in the spaces while maintaining structural integrity. The teachers in the classrooms need to be able to have control over the electric lighting, as well as the daylighting, in their rooms to create an optimal learning environment.

1.1 Owner Goals

safety & security



Safety is of utmost importance for the Reading School District. Having a sense of 'unseen' security will enhance the feeling of safety for the occupants. This, too, must address the possibility of incendiary events unfortunately becoming prevalent in today's society.

lifecycle & maintenance



Lifecycle relates to how well the building will perform over time. Since this building will likely be in use for 50 or more years, it is imperative that the school functions well over time. The school must also be easily maintained to ensure that the building will last.

cost effective



Reading School District needs a building that is cost effective in both the short and long term. All design decisions were analyzed to ensure that the greatest value was achieved. Nexus' building system and material selections alleviate first costs, while maintaining the integrity and affordability in the long run.

All of these goals are continually reiterated throughout the design of the Reading Elementary school. As such, it was decided that the following Mission Statement be Nexus' foundation for all design decisions.

Nexus' Mission Statement:

To develop a design that merges education with the community in a facility that is safe and cost effective while functioning as a learning tool.

1.2 Nexus Goals

Nexus' project goals were developed to achieve the owner goals and are supported by the individual discipline objectives.

integration



Integration is the all-encompassing goal of meeting the owner's objectives. As the main architectural components of the building were already established, Nexus focused on integrating the structural, mechanical, and lighting/electrical designs with the constructability of the building through predefined discipline goals and established information exchanges.

reduce, recover, reuse



This holistic building design was produced through lean practices. These lean practices were achieved by reducing, recovering, and reusing. These are reflected in all four design disciplines' decisions in order to save construction time, initial and lifecycle cost, as well as energy.

learning tool



Nexus desired to create a building that could be used as a learning tool for the end users. The building has exposed ceilings to allow users to understand the function of the exposed structural, mechanical, and electrical elements. All of these items were coordinated through extensive planning to meet the necessary discipline performance requirements.

1.3 Lighting Goals

From the Owner Goals, design criteria for the lighting system were created to provide an atmosphere conducive to learning. The first design criterion is for all of the spaces to meet appropriate IES recommended light levels, to ensure that there is enough light to accomplish the tasks required in each space. Table 1 outlines the target light levels for the spaces described in this report. These light levels need to be met with respect to cost effectiveness, as well as with respect to maintainability.

Space	Illuminance level (fc)
Lobby	15
Gym	40
Pool	40
Classroom – Horiz.	30
Classroom – Vert.	20

-Table 1-

Additionally, the building needs to meet the lighting power densities (LPDs) for each space to help maintain low energy usage, which in turn helps the school to be cost effective. Table 2 outlines the LPD requirement for each space taken from the space-by-space method of the 2007 ASHRAE 90.1 standard.

Space	Target LPD (W/ft ²)
Lobby	1.8
Gym	1.4
Pool	2.7
Classroom	1.4

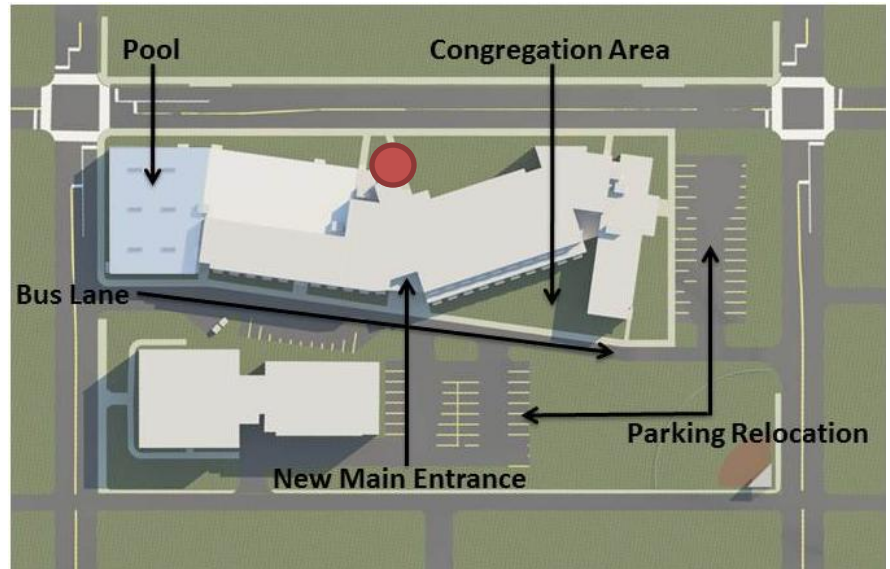
-Table 2-

The third criterion is for the lighting system to be easily adapted to the needs of the client. The first need being first and foremost the safety of the students and staff. Another need is for the teachers to have full control over their classrooms, meaning that teachers need to be able to control the electric lighting with dimming and switching as well as the daylighting with manual shades. Control of the lighting system throughout the building also needs to be able to save the school money by reducing the amount of energy consumed.

2. Experience

2.1 Campus

Since Reading has one of the worst crime rates in Pennsylvania, the safety of the students and staff is paramount. Therefore, to meet the owner’s objective of safety, the building was modified to have the entrance of the site relocated to the interior of the campus. As seen in Figure 1, the original main entry to the school, shown by the red dot, was along a busy road, which does not allow optimal protection of the students. Instead, the main entrance of the school was flipped, so that the campus has turned in on itself, allowing for more secure access to the building. There is now a congregation space for the students to wait when being dropped off and picked up from school which is sheltered. For more information on the increased security of the building, please refer to Nexus’ Integration Report.



-Figure 1-



-Figure 2-
Selux

The safety of the occupants throughout the campus is increased by incorporating enough light for facial recognition, which is important in recognizing potential dangers to the school, the students, and the faculty. Pole fixtures, such as the one seen in Figure 2, that emanate light in the vertical plane, in addition to illuminating the ground plane, will allow for the goal of safety to be achieved. Similar fixtures are used at the World Trade Center Memorial specifically for facial recognition and to prevent crime. Illuminated bollards will improve way-finding to the entrance of the school, while providing adequate pathway illumination. Because the location of the school is in a crime-prone area, it was determined that safety was paramount over the school achieving the LEED credits related to dark sky compliance.

2.2 Lobby

The lobby of the Reading Elementary School is the gateway to the school. It needs to create a sense of security, as well as maintain a welcoming atmosphere. The curtain wall in the lobby will allow ample amounts of daylight to enter the space and creates a link to the outside. The windows of the curtain wall will be bullet-resistant glass, to ensure the safety of the occupants.

The main feature of the atrium will be three rings of light that will appear to be floating at various heights, creating visual interest and a welcoming atmosphere, as seen in Figure 3. Downlights will provide the general lighting for the vestibule and for the lobby/atrium when needed. The AGI32 calculations for the lobby can be found in the Supporting Documentation (page 13).



-Figure 3-

2.4 Lobby Rationale

The lobby has a curtain wall window system that will let in ample daylight; however, it has minimal sun shading. This is due to the fact that the lobby is open to circulation spaces. Occupants will rarely be standing or sitting in this space for any length of time; therefore, glare from the direct sunlight was deemed to be minimal.

Because the lobby of the school needs to welcome every visitor, it needs to have an atmosphere that makes people want to enter the space. The “floating” rings, such as the one in Figure 4, help to give the large atrium some visual interest, as well as draw people inside. When selecting a fixture for this application, it is important to ensure that the fixture is visually appealing from both the top and the bottom sides, as the fixture can be viewed from any direction. The frosted lens ensures visual comfort, regardless of viewing angle. However, the rings alone do not give off enough light to be adequate for the three-story atrium, so metal-halide downlight fixtures are used to give ambient light to the vestibule, as well as to the remainder of the lobby. Metal halide lamps were chosen over LED fixtures because they were deemed to be more efficient at lighting the space, as well as being more cost effective for lighting a three-story atrium. The downlights will be used at night and when there is an inadequate amount of daylight in the space. Detailed lighting calculations can be found on page 13 of the Supporting Documentation.



-Figure 4-

The electric light levels and the lighting power density can be seen in Table 3. While the lobby light levels are right around the target illuminance, the light levels for the vestibule are slightly increased to 20 fc to help with security. Because of the three-level atrium, the target LPD from ASHRAE 90.1 is 1.8 W/ft²; however, this design saves wattage by having an actual LPD of 1.098 W/ft². The calculation area for the LPD can be seen in the Supporting Documentation on page 13. Lowering the LPD will help to save energy, which increases cost effectiveness. The wiring diagram for the lobby can be found in the Supporting Documents (page 13).

Target Illuminance	Actual Illuminance
15 fc	15.03 fc
Target LPD	Actual LPD
1.8 W/ft ²	1.098 W/ft ²

-Table 3-

To create a learning tool out of the school, the electrical lighting system will be tied into a single control system that works seamlessly with the mechanical system, which will have an interactive display in the lobby. The display panel will be able to give data on the building with regards to peak building loads and usage. It will be interactive to allow the students to learn about saving energy and the functions of a building.

3. Community

3.1 Multipurpose Room – (Gym, Shelter, Cafeteria, Auditorium)



-Figure 5-

The gym of the Reading Elementary School, seen in Figure 5, also functions as the cafeteria and assembly room for the students. The space will be open to the community after school hours for activities such as basketball leagues or community events. With many different functions, comes the necessity to have a lighting scheme that can adapt to the uses of the space.

The space will also function as an emergency shelter when needed; therefore, there are no windows or skylights. The

space will solely be lit with electric light. Compact fluorescent, high-bay fixtures with a dimming capability will be used.

3.2 Multipurpose Room Rationale

Since there can be no daylight in the gym due to the structural requirements of making it a shelter (for more details on the shelter, please refer to Nexus' Structural Report), only electric light can be used to light the space. However, since the space needs to be versatile, the lighting needs to be versatile as well.

To achieve the versatility and adaptability needed for the space, a compact fluorescent sports lighting fixture was selected, such as the one in Figure 6. A fixture using 8 compact fluorescent lamps was chosen because the compact fluorescent lamps will allow the fixture to be turned on and off without having to wait for the restrike or start-up time, as with metal halide lamps. This characteristic is important because of the versatility of the gymnasium. The fixtures need to



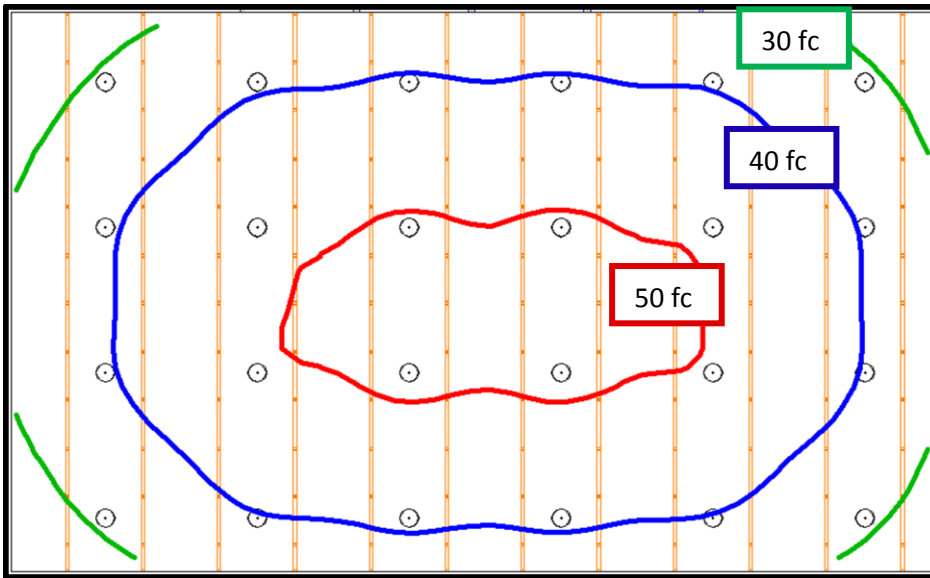
-Figure 6-

Target Illuminance	Actual Illuminance
40 fc	41 fc
Target LPD	Actual LPD
1.4 W/ft ²	1.4 W/ft ²

-Table 4-

be able to adapt to the function of the space. This type of high-bay fixture was chosen over a linear fluorescent fixture even though the linear fluorescent fixture would have better maintenance costs because of aesthetic reasons; however the slightly higher maintenance costs can be diminished by group re-lamping the fixtures.

An array of these fixtures allows the space to have uniform lighting for optimal performance. A high degree of uniformity is needed because of the nature of the space since most sports require there to be adequate and even



-Figure 7-

lighting to ensure the performance and safety of the players. Figure 7 shows the layout and the illuminance contours of the space and Table 4 shows the light levels as well as the LPD. As demonstrated in Table 4, this design for the gym meets the light level and LPD criteria effectively.

Because each fixture has 8 lamps, the lamps can be controlled in two groups, adding more flexibility to the space. Dimming capability also allows for more control over the space, which is particularly important for assemblies and use of the stage. Because of the level of versatility needed, all fixtures will be run on dimming ballasts. More information on the switching and wiring of these

fixtures can be found in the Supporting Documentation (page 15).

Another consideration is use of the gym as an emergency shelter. There needs to be enough light for safety purposes; however, the light levels need to be able to reach a low enough level that the occupants can sleep without affecting their circadian rhythms. Therefore, 4 luminaires (one in each corner of the room) will serve as emergency lighting. The specific layout for the luminaires on emergency power can be seen on page 14 of the Supporting Documentation. The space was determined to have a low degree of hazard, meaning that there is a high enough

contrast, and no change in the level of the floor plane, and a high circulation activity; therefore, the IES recommended light level is a minimum of 0.8 footcandles for safety. With the 4 luminaire solution, the average illuminance is 5.55 footcandles with a minimum of 2.2 footcandles. To reach a light level suitable for sleeping, the fixtures will be able to be switched to have half the amount of light output. The calculation for the emergency lighting can be found in the Supporting Documentation (page 14).

3.3 Pool

The pool, seen in Figure 8, is the area of the building where the community and the school are the most integrated. Since anyone is welcome to use the pool, it needs to have a welcoming atmosphere that doesn't hinder either the swimmers' or the spectators' visibility.

In terms of daylighting, there is a large north facing window to let in diffuse daylight. There are also 6 skylights that are made of a diffuse material. The electric lighting consists of indirect fixtures that will bounce light off of the ceiling to light the space. This will also help to minimize glare on the surface of the water. Care was taken to integrate the daylighting and electric lighting with the structural system, in order to create a more seamless design.



-Figure 8-

3.4 Pool Rationale

One of the driving design considerations for the pool area was to minimize the amount of direct light onto the surface of the pool, as this can be very irritating and potentially hazardous to the swimmers. The prevention of glare on the surface of the pool is the main reason why there is no south facing glazing, since south facing windows would let in too much direct sunlight through much of the year. The large north facing window will not let in direct sunlight. Instead, it will provide a nice diffuse light to the space. The skylights (layout in Figure 9) also add to the layer of daylight. They are diffuse, instead of clear, to minimize the amount of direct sunlight. This option was deemed better for this application over a clear skylight with louvers in order to help maximize the amount of light that reaches the surface of the water and the floor while minimizing glare.



-Figure 9-

Target Illuminance	Actual Illuminance
40 fc	42 fc
Target LPD	Actual LPD
2.7 W/ft ²	1.99 W/ft ²

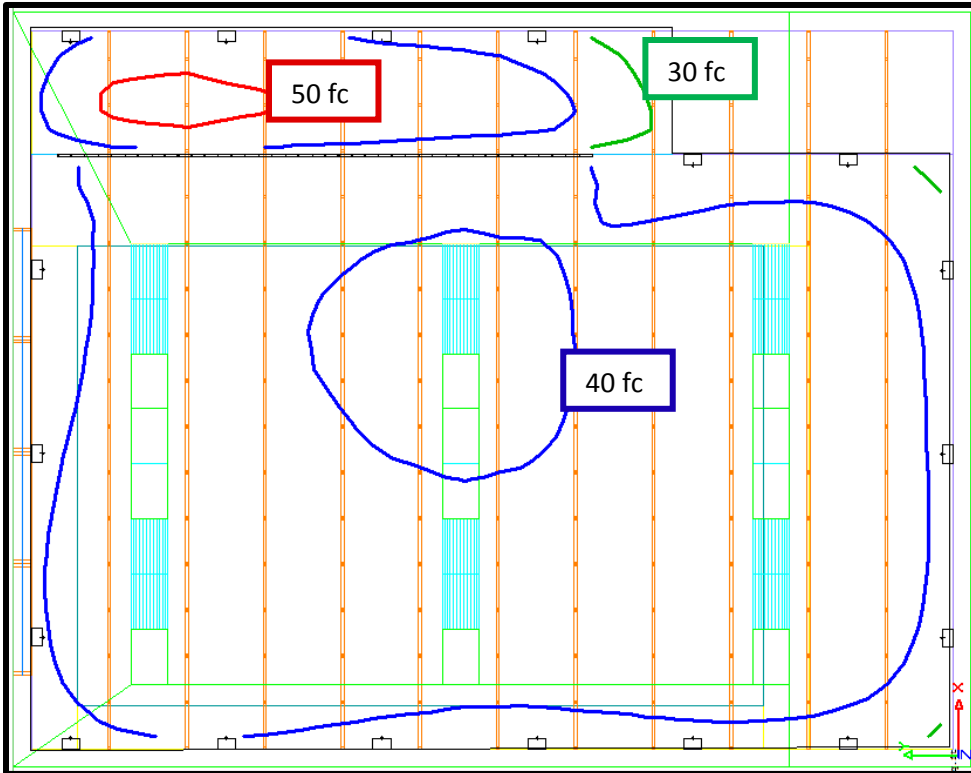
-Table 5-

Calculations of the daylighting analysis can be found in the Supporting Documentation (page 16-19). As seen in the daylighting analysis, for most days of the year, it is not a viable solution to use only daylight to light the space. However, the combination of daylight and the electric lighting on at half-output will yield the desired light levels on the pool deck during the day.

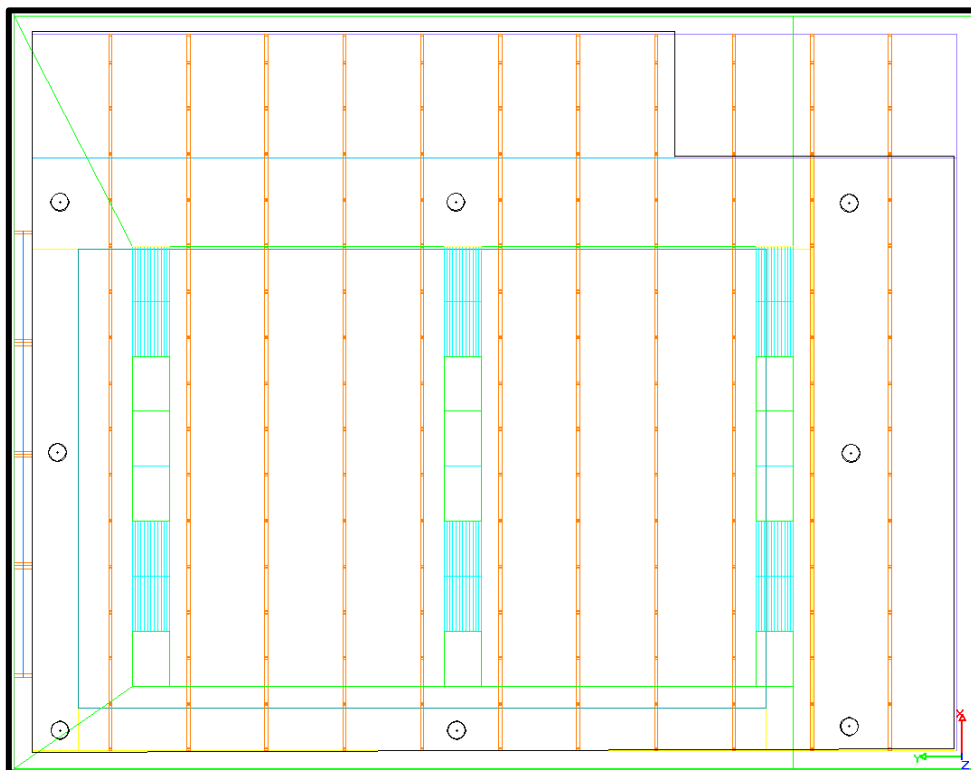
The electric lighting of the pool area is also indirect to prevent additional glare on the surface of the pool. The fixtures are wall-mounted, indirect fixtures using metal halide lamps, as can be seen in Figure 10, to wash the ceiling with light, which will then light the space. The fixtures are wall-mounted, as opposed to ceiling-mounted to facilitate maintenance, since there would be no need to drain the pool for lamp replacement. In order to reflect enough light off the ceiling to illuminate the pool deck, a fixture with (2) 400W metal halide lamps was used. As such, the light levels and LPD for the space are given in Table 5. Direct, wall-mounted fixtures on the lower wall of the balcony give additional light to the space, as well as provide more visual interest.



-Figure 10-



-Figure 11-



-Figure 12-

Figure 11 shows the luminaire layout and the illuminance contours for the pool area as well as for the upper viewing deck. As seen, the pool deck attains a 40 fc average.

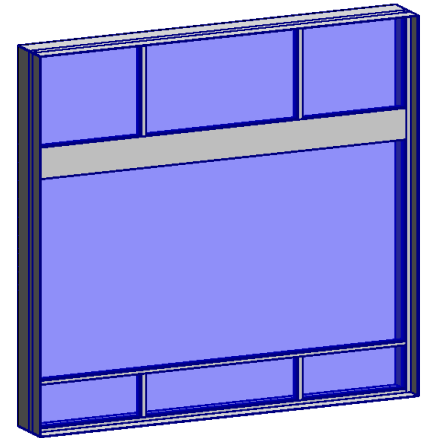
Emergency lighting for the pool is extremely important for the safety of the occupants. There needs to be more light concentrated around the edge of the pool to prevent people from accidentally falling in, in the event of a power failure. Therefore, compact fluorescent fixtures over the pool deck will be used. Compact fluorescent lamps are capable of immediate switching, which is the reason for their selection over ceramic metal halide. The minimum light level is 4 footcandles; however, the design shown in Figure 12 has a minimum of 6.6 footcandles and an average of 10.21 footcandles. More detailed emergency lighting calculations can be found in the Supporting Documentation (page 20). The same fixtures will be used for the emergency lighting in the pool area as in the gym for easy maintenance. Using the same fixtures will also reduce the amount of different lamp types required, which will save the school system money in maintenance costs. Wiring diagrams for the emergency lighting and the regular lighting can be found in the Supporting Documentation (page 21).

4. Education

4.1 Classroom

The classrooms in a school are the heart of the building. As such, Nexus has striven to create spaces that facilitate learning. The lighting solution for this building combines daylight and electric light to give the teachers control over their classroom.

The windows for the Reading Elementary School were designed in conjunction with the mechanical and structural teams to create a system that benefits all areas, and reinforces the integration aspect of Nexus. The windows created are 7 feet by 8 feet, which helped to determine the module of the building to be 7 feet. By allowing all of the classrooms to have the same window, the cost of the building can be reduced due to the modularity. Figure 13 to the right shows the window geometry that will be used.

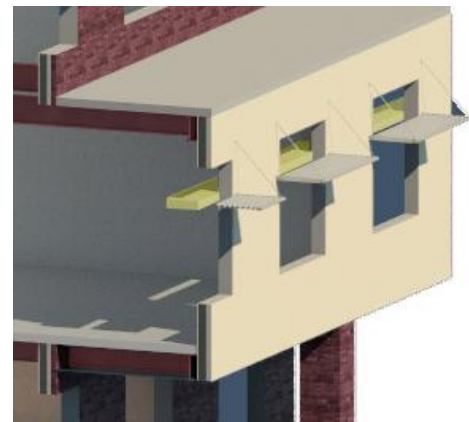


-Figure 13-



-Figure 14-

In order to create a comfortable environment, daylight must be delivered to the space in a manner that lets in plenty of light, without having direct glare from the sun. The main areas of the building that will have an issue with direct sunlight are located on the southern facing facades. On these facades, the windows will have a louvered exterior overhang; similar to the one pictured in Figure 14 from Hunter Douglas, which will aid in preventing direct, high-angle sun from entering the room. The overhangs are not deemed necessary on the other faces of the building because they will receive minimal direct sunlight.



-Figure 15-

Also on the southern facades, light shelves will be used to take advantage of the southern sun, to improve the daylighting of the space. Whereas the 8-foot wide exterior overhangs were over each window individually, the light shelves will span the entire width of the classrooms. This, along with the high reflectance of the shelf, will help to more uniformly catch the light at more hours of the day. Figure 15 depicts the sun shading system. A daylight study for a sample classroom can be found in the Supporting Documentation (page 22-27).

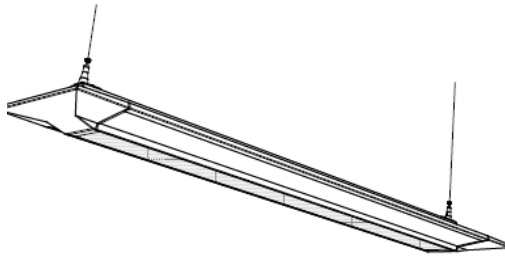
The general lighting for the classrooms will consist of semi-direct linear luminaires, as seen in Figure 16. These fixtures have the capability of being dimmed, and will be able to be switched in zones, in relation to the daylight in the space, which will help to save the school energy. The fixtures will use photosensors that the teachers will be allowed to override with a wall-mounted control system to meet their needs while teaching. There will be task lighting as well with wall-mounted fixtures above the whiteboard and under-cabinet lighting by the sink. Occupancy sensors will also be used in the classrooms to help save energy and money.



-Figure 16-

4.2 Classroom Rationale

Since cost-effectiveness is one of the driving goals for Nexus, we have designed building systems that are modular. One way that this was achieved was by having the same window throughout all of the classrooms. This will allow for the windows to be built in bulk, and they will all be installed in the same fashion. This will also help to reduce construction time.



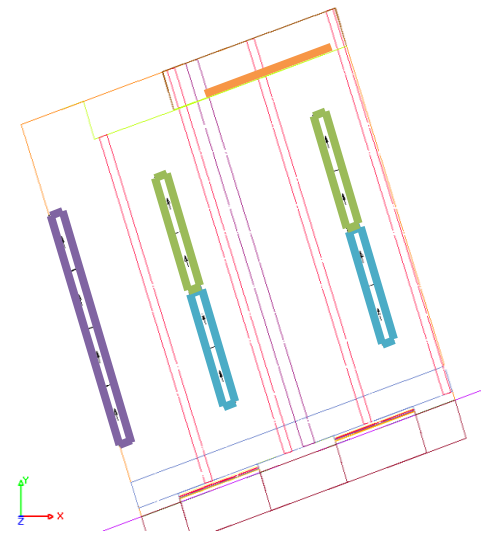
-Figure 17- Axis Lighting

The southern façade needs to have daylight control, since it will receive direct sunlight throughout the majority of the school day. Due to this, an overhang/light shelf system has been designed. Overhangs will help to minimize the amount of direct sunlight that enters the space, but are most effective at blocking the high-angle sun. The louvered overhangs are 8 feet long, instead of having one continuous overhang over the length of the building, to be wide enough to cover the entire window while still maintaining coverage for early morning and evening sunlight. The shorter overhang will reduce the amount of material needed and will reduce cost. This sun shading system is also a much lighter system than a solid overhang,

which will reduce the load on the walls. The overhang is paired with the light shelf to allow daylight to penetrate farther into the space, while still blocking direct sunlight at certain times of the day. When the overhang is no longer adequate to block the direct sunlight, fabric shades can be lowered when necessary to block out unwanted sunlight. The results of the daylight study conclude that through much of the winter, the shades will need to be lowered due to the lower angle sun. In the spring and fall, the shades will be able to be raised to take advantage of the sunlight during the school day, especially in the hours past noon. The sunlight will help in creating a pleasant atmosphere conducive to learning.

The electric lighting in the classroom will consist of direct-indirect T5 luminaires, as seen in Figure 17, to provide general lighting to the classroom, as well as a wall-mounted T5 luminaire mounted over the whiteboard to provide more light to the space. There will also be under-cabinet task lighting. The electric lighting calculation can be found in the Supporting Documentation (page 28).

Since energy savings is also another concern with the school, the luminaires will be installed with photosensors, which will help to control the luminaires when there is adequate daylight. The photosensors will tell the luminaires to either switch to an off or dimmed state when there is enough daylight in their zone. Each classroom will be divided into 4 zones: two zones controlling the general overhead lighting, one controlling the whiteboard lights, and one controlling the under-cabinet lighting. The zone closest to the windows in the overhead lighting will be the one to be dimmed or switched off depending on the daylight levels. Figure 18 depicts the zoning of the luminaires in a classroom. The purple box represents the whiteboard lights. The green and blue boxes are the overhead lighting zones, and the blue boxes are the zone that will be dimmed in response to the daylight. The orange box represents the under-cabinet lighting. A more detailed switching/ wiring plan can be found in the Supporting Documentation (page 28).



-Figure 18-

Target Illuminance	Actual Illuminance
30 fc	31 fc
Target LPD	Actual LPD
1.4 W/ft ²	0.94 W/ft ²

-Table 5-

The purple box represents the whiteboard lights. The green and blue boxes are the overhead lighting zones, and the blue boxes are the zone that will be dimmed in response to the daylight. The orange box represents the under-cabinet lighting. A more detailed switching/ wiring plan can be found in the Supporting Documentation (page 28).

Table 5 shows the illuminance values with only electric lighting and the LPD of the space. As shown, this design meets the target illuminance level, while saving energy by having an LPD significantly lower than the target.

5. Conclusion

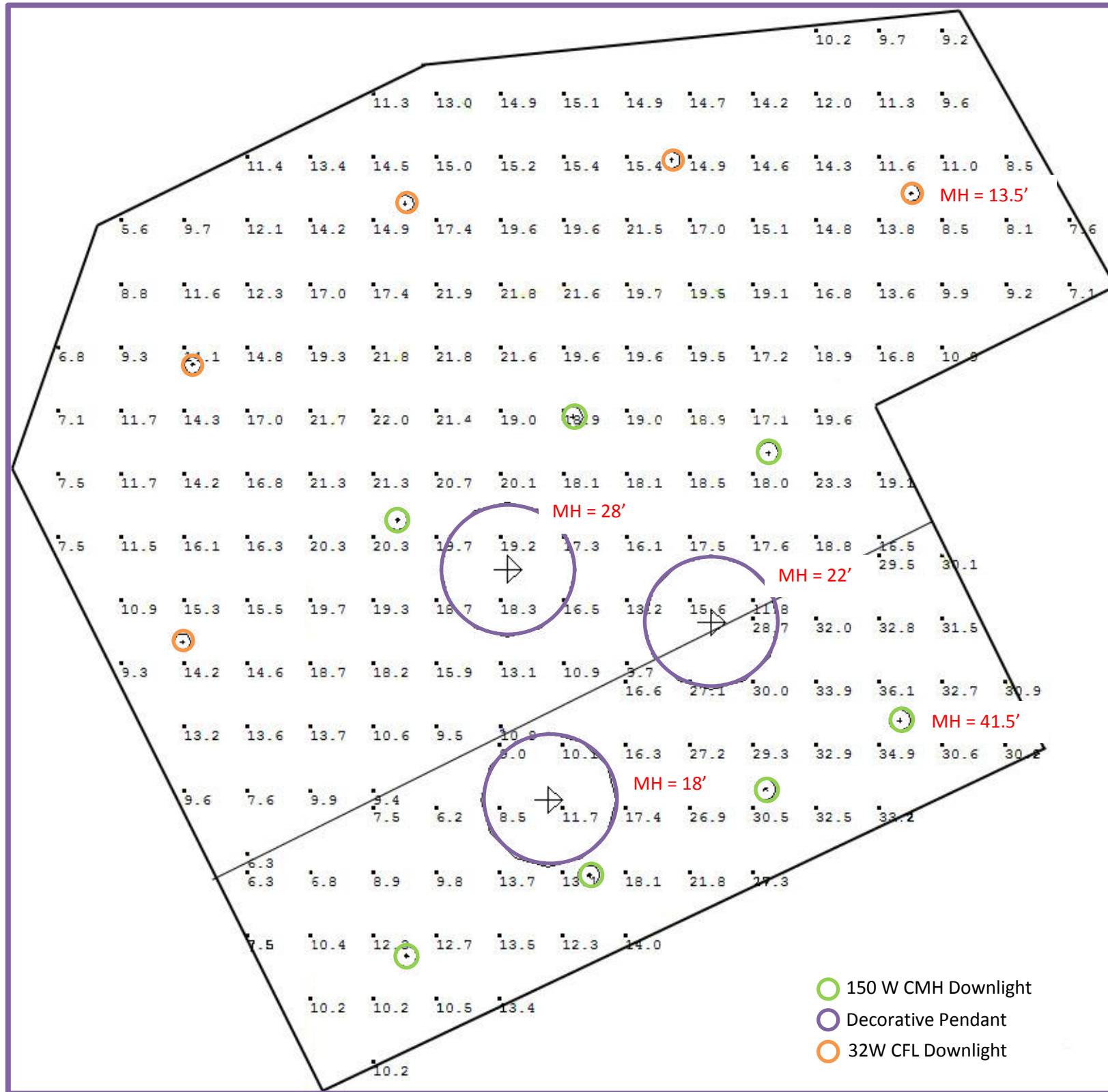
In conclusion, Nexus has met the Reading School District's owner objectives through the support of the project and discipline specific goals. The goals set forth by Nexus were created in order to deliver a building that satisfies the needs of the students, teachers, and community members. The proposed elementary school successfully achieves and exceeds the district's objectives. The Reading Elementary school contains a plethora of examples of innovative design solutions through each of the integrated disciplines working on the project.

Through the use of integration, the lighting/electrical team has striven to provide a plan for the elementary school that is cost effective, energy efficient, and aesthetically pleasing that meets the needs of the owner. The **Experience** section of the school welcomes students and visitors alike while maintaining a secure feeling. The **Community** section creates two different spaces that work to give back to the community, as well as to provide versatile facilities to the students. The **Education** section gives teachers the ability to empower their students with high-quality learning facilities and bright, cheery classrooms.

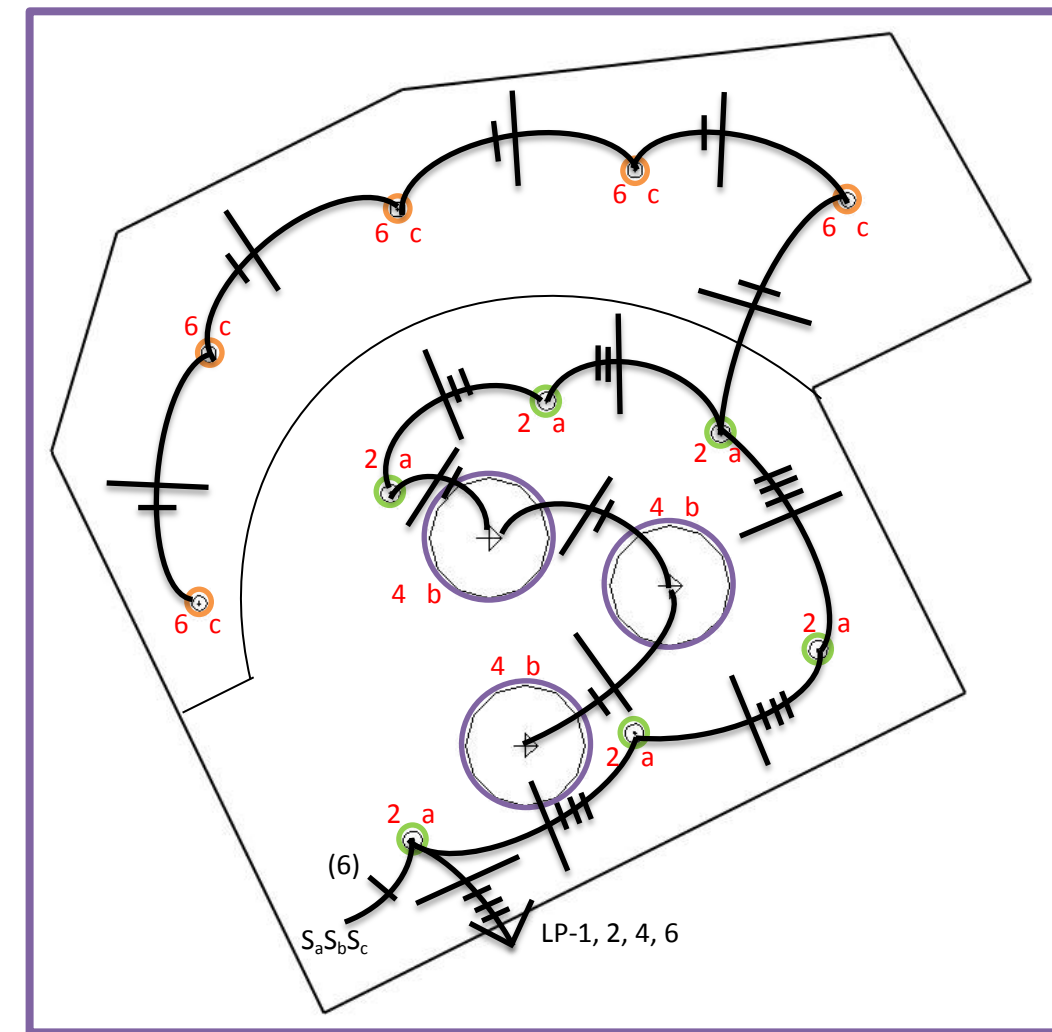
Overall, the lighting/electrical team, and Nexus as a whole, has come together to deliver building systems that are fully integrated to the best of our abilities that meet the owner's goals efficiently and effectively.



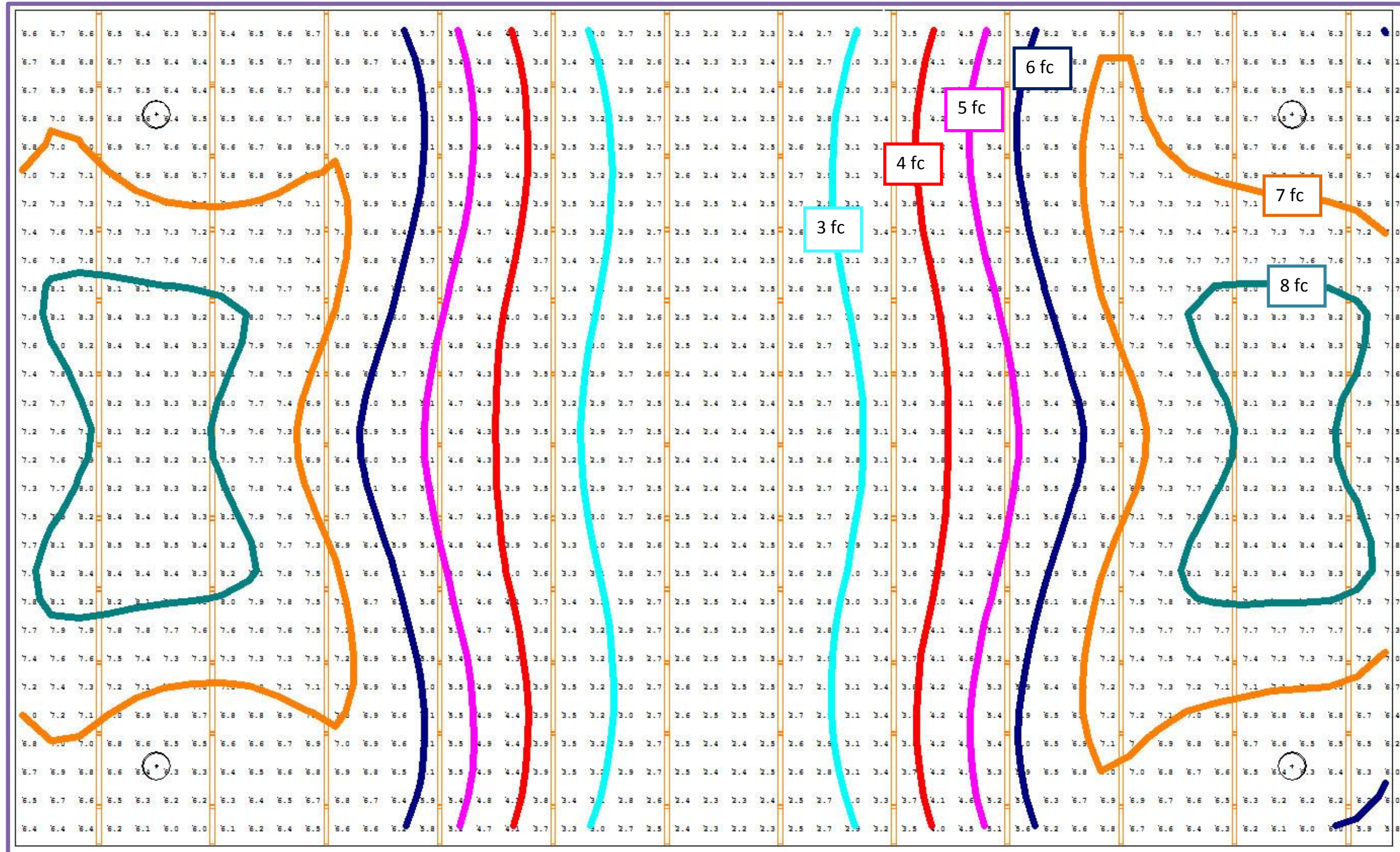
6.1 – Lobby: AGI32 Calculation and Switching Diagram



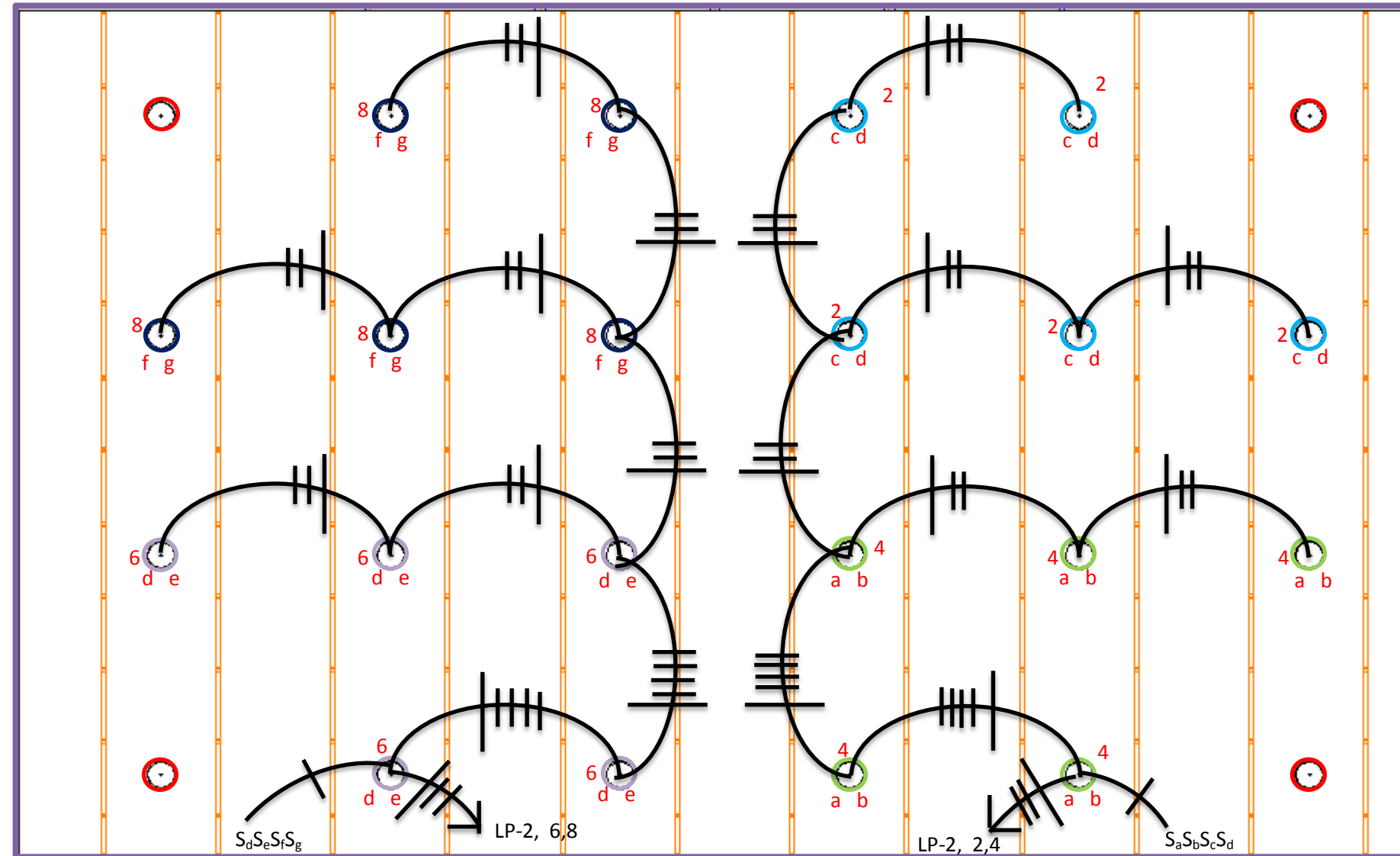
Calculation Summary					
Label	Units	Avg.	Max.	Min.	Max/Min
Lobby	FC	15.03	23.3	5.6	4.16
Vestibule	FC	20.19	36.1	6.2	5.82
Total Watts LPD		1523.35W 1.098 W/ft ²			



6.2 – Multipurpose Room: Emergency Lighting Calculation

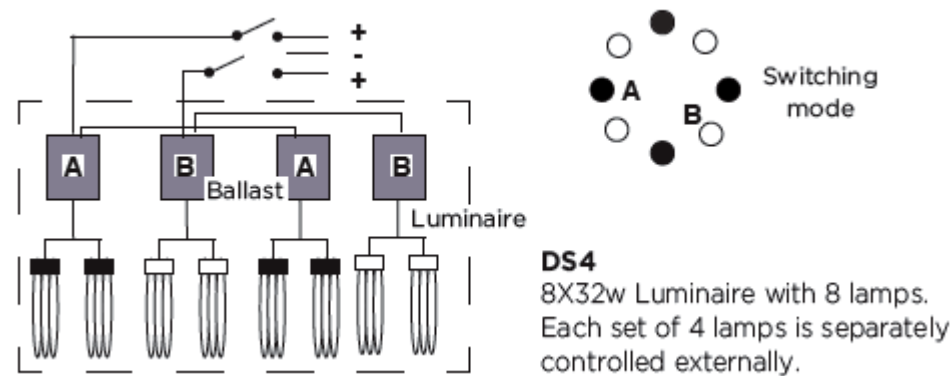


6.3 – Multipurpose Room: Switching Diagram



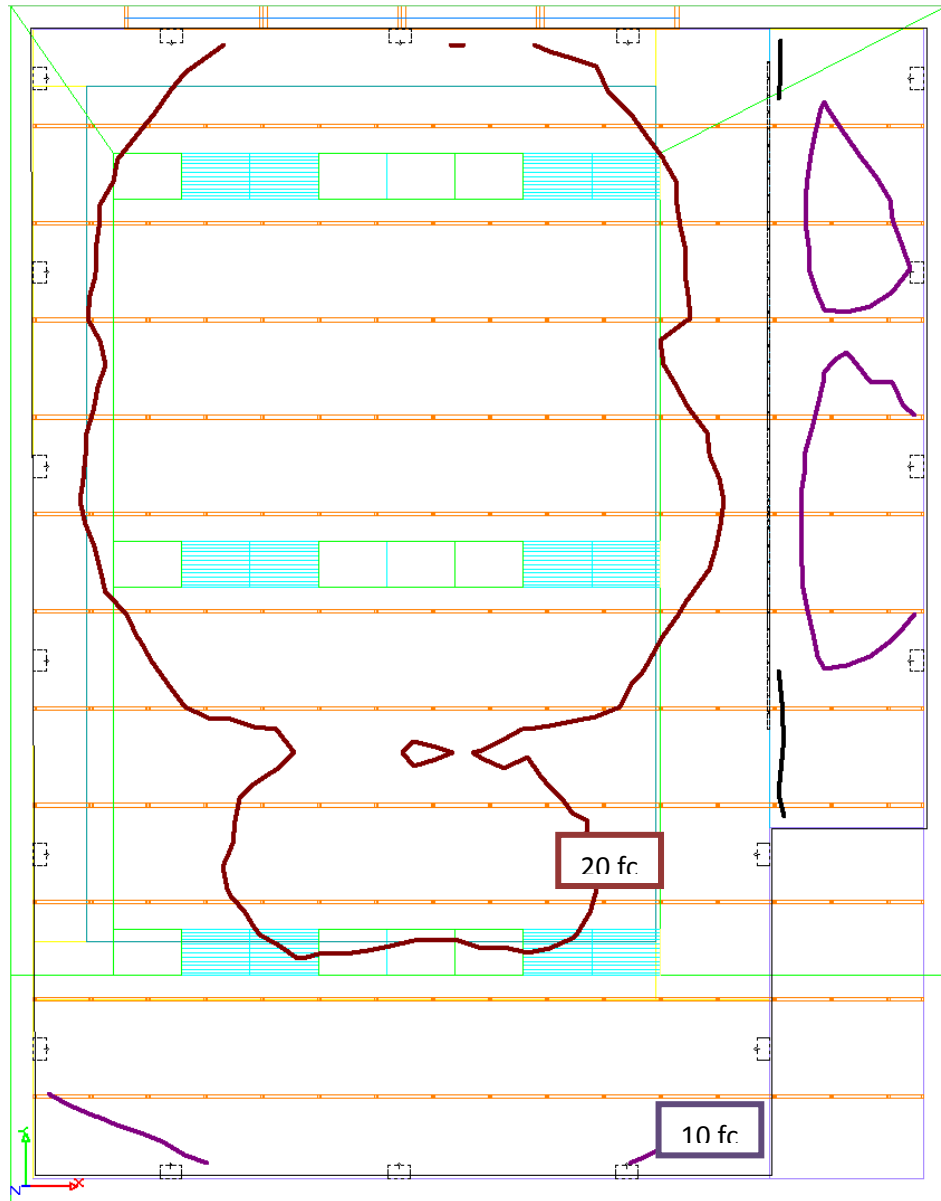
- Zone 1
- Zone 2
- Zone 3
- Zone 4
- Emergency – These 4 will be switched together on a separate emergency power panel

NOTE: All switches will be single-pole switches. There will be two sets of switches, one set for each half of the gym. The front half of the gym (Zones 1 and 2) will be on circuits 2 and 4, respectively. The back half of the gym (Zones 3 and 4) will be on circuits 6 and 8, respectively. Each zone will have two switches- one to control the A group of lamps and the other to control the B group, as seen in the figure on the bottom, left of this page. The switches are single-pole to give additional ease-of-use to the owner with a single control area.

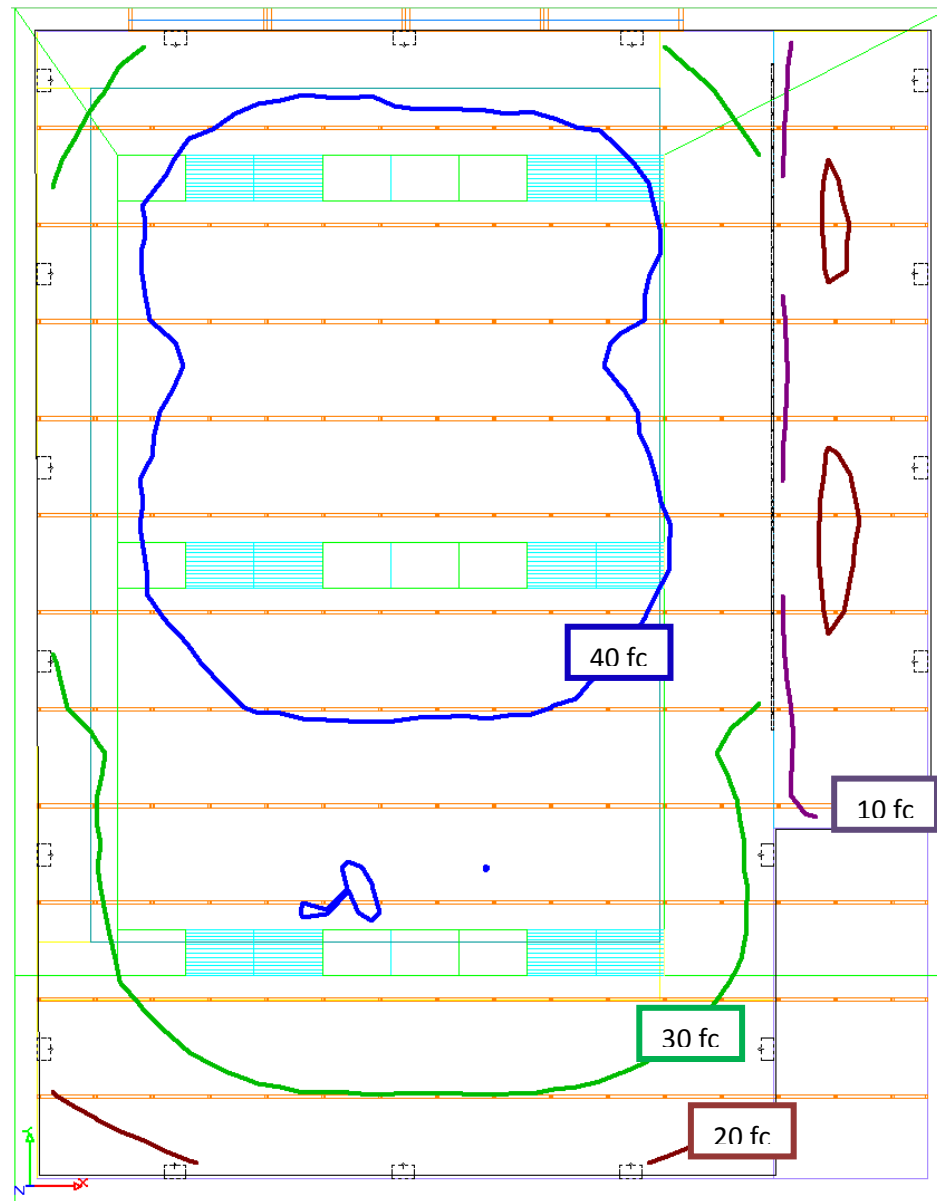


Source: LUMINIS PRISMA NOVA 22

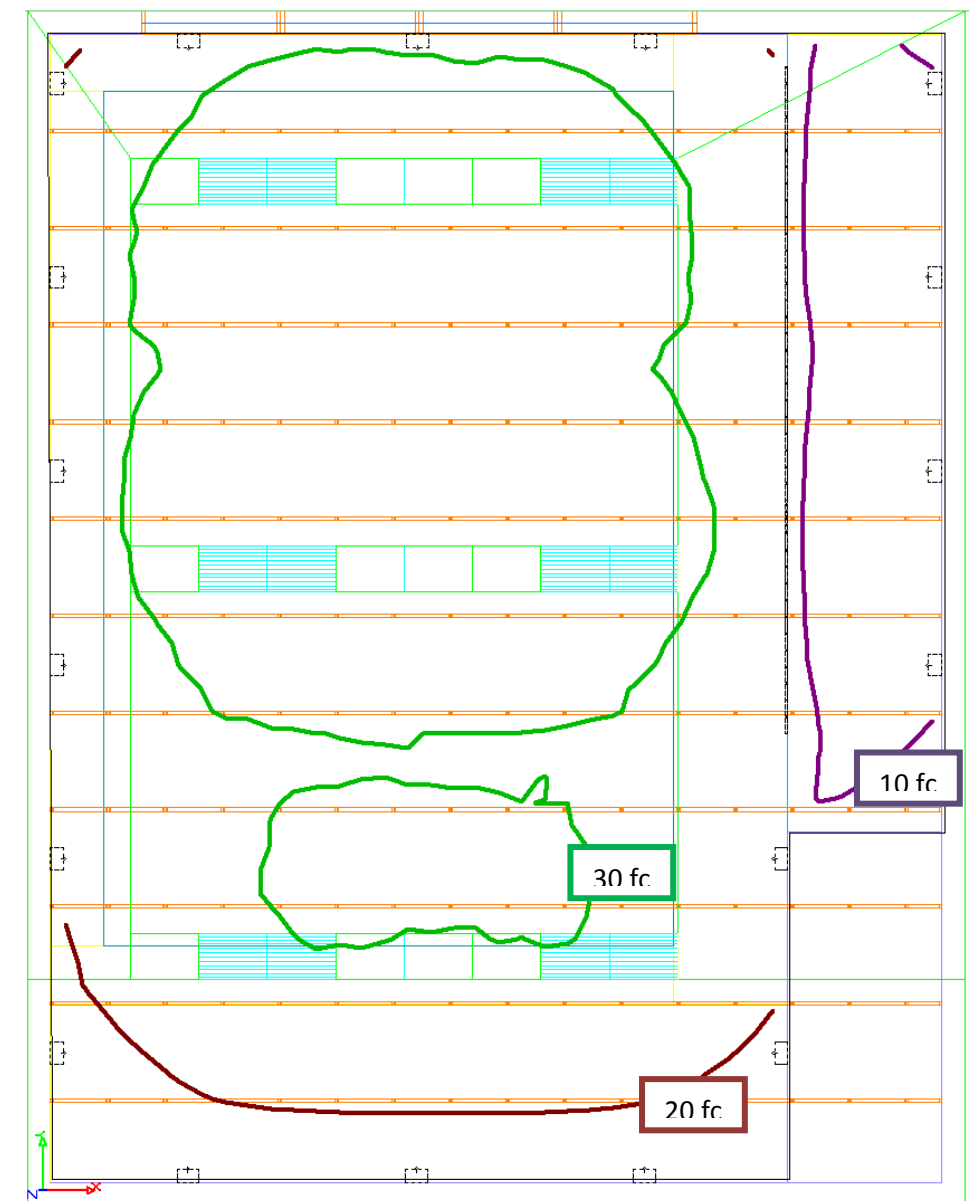
6.4.1 – Pool: AGI Calculation of Daylight ONLY



Winter Solstice – Clear Sky, Noon



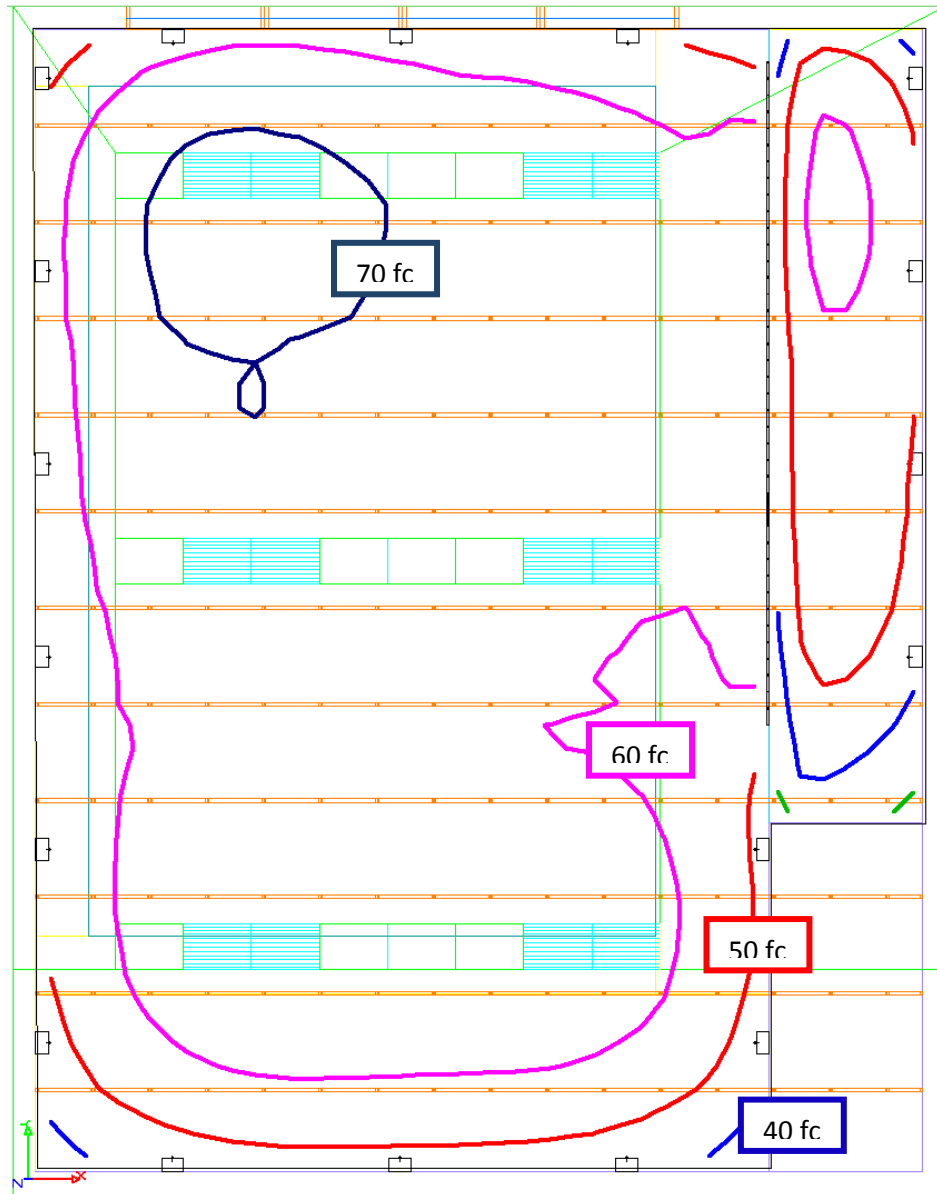
Summer Solstice – Clear Sky, Noon



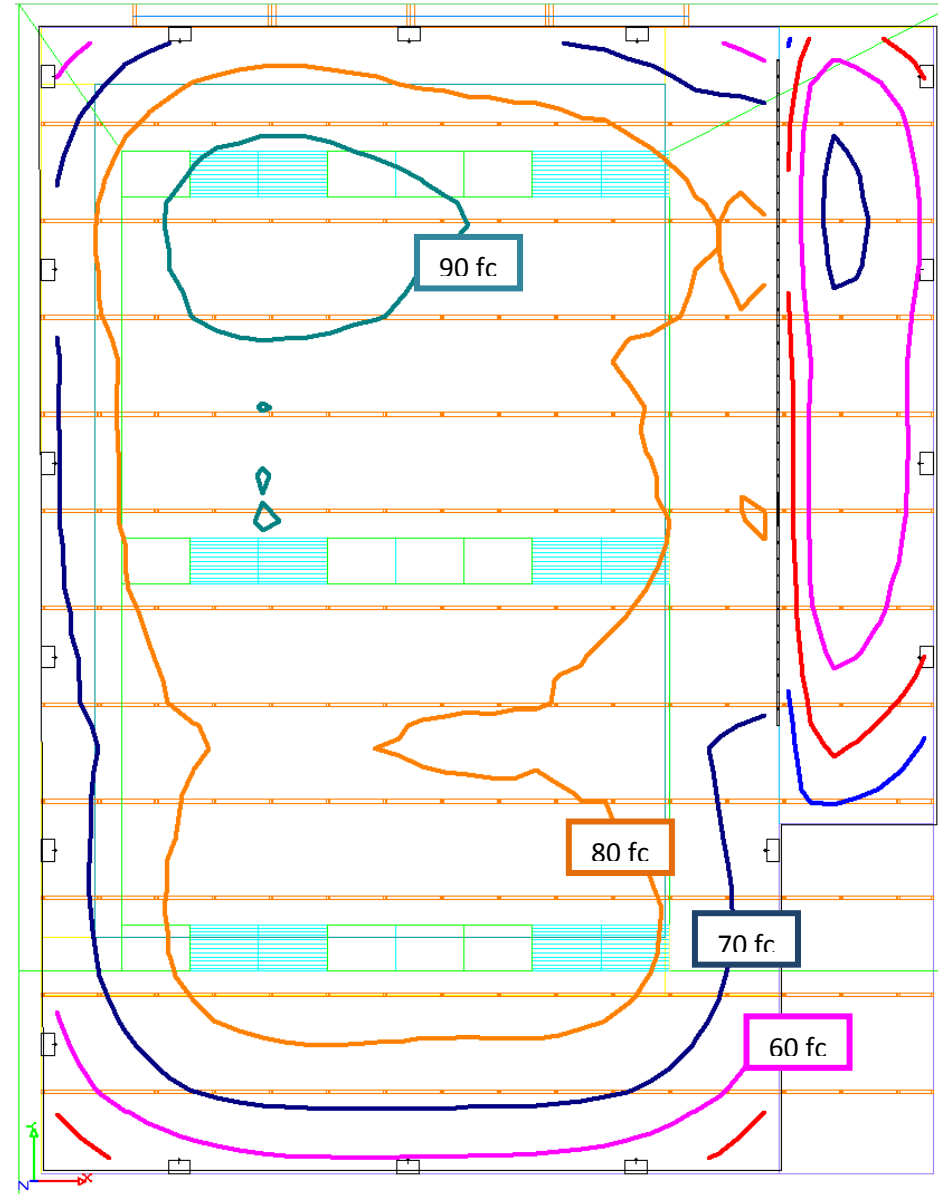
Spring/Fall Equinox – Clear Sky, Noon

NOTE: During most times of the year, daylight alone does not yield sufficient daylight levels; therefore, lights may be operated at half-output during the day throughout much of the year. This will allow the school to save money on energy costs.

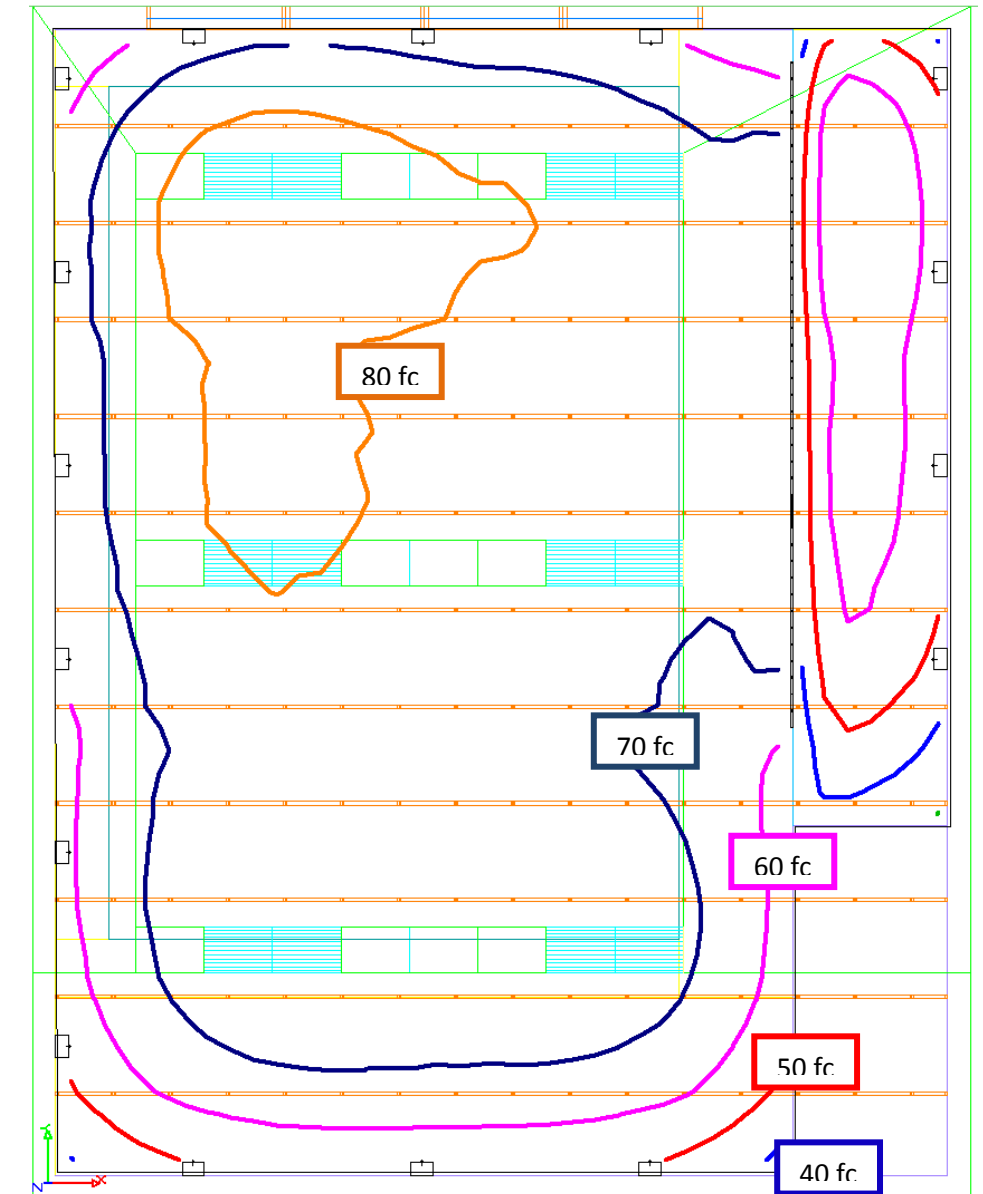
6.4.2 – Pool: AGI32 Calculation of the Combined Electric Lighting and Daylight



Winter Solstice – Clear Sky, Noon



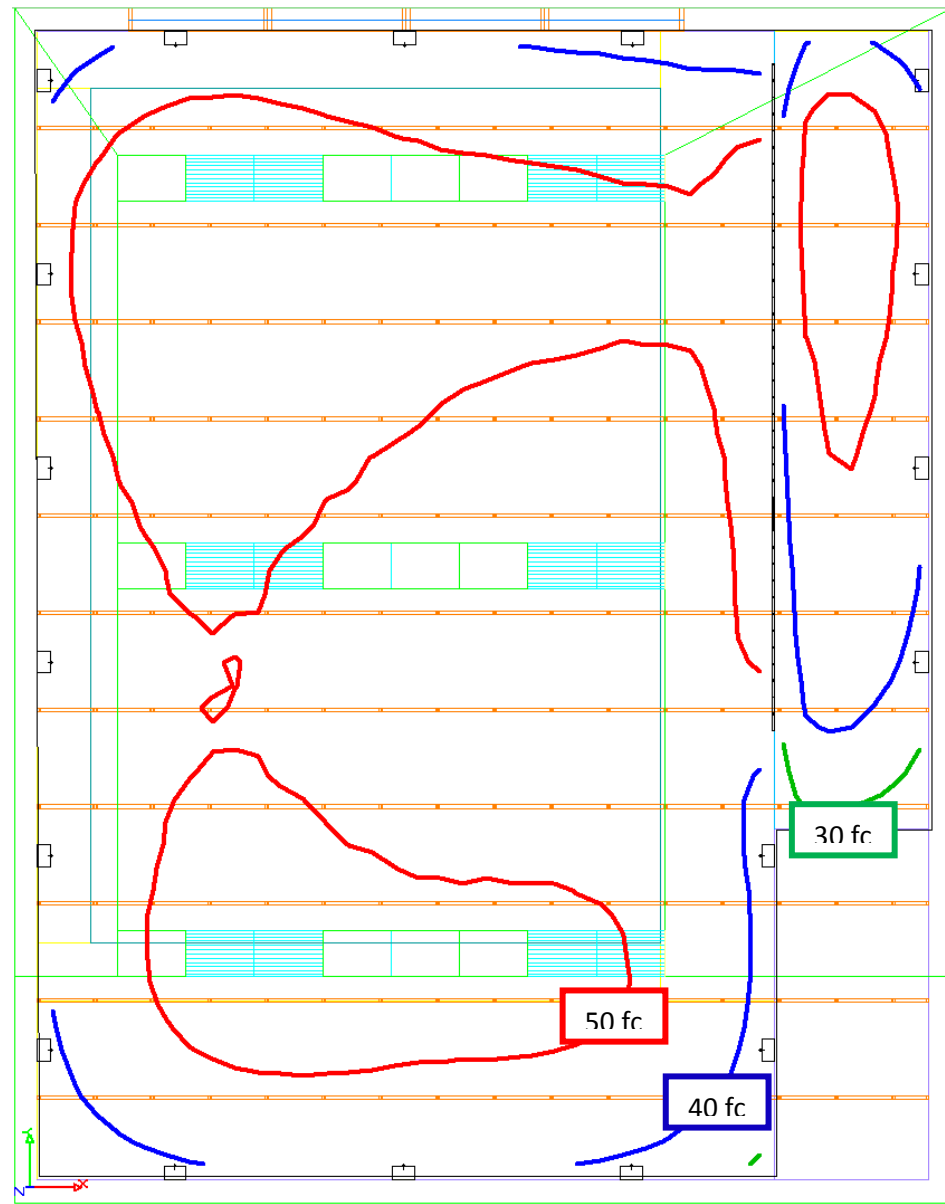
Summer Solstice – Clear Sky, Noon



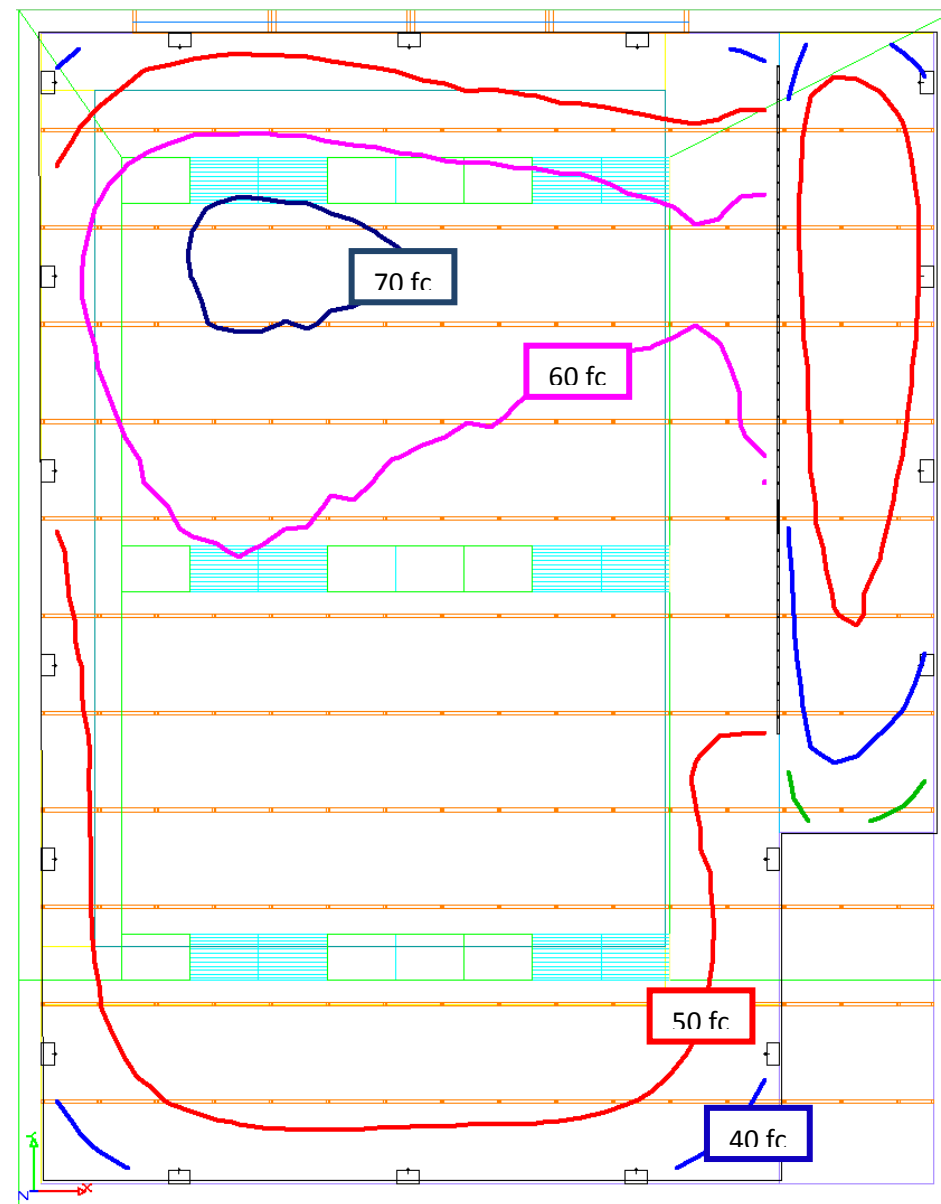
Spring/Fall Equinox – Clear Sky, Noon

NOTE: Lights may be operated at half-output during the day throughout much of the year when there is sufficient daylight in the space. This will allow the school to save money on energy costs.

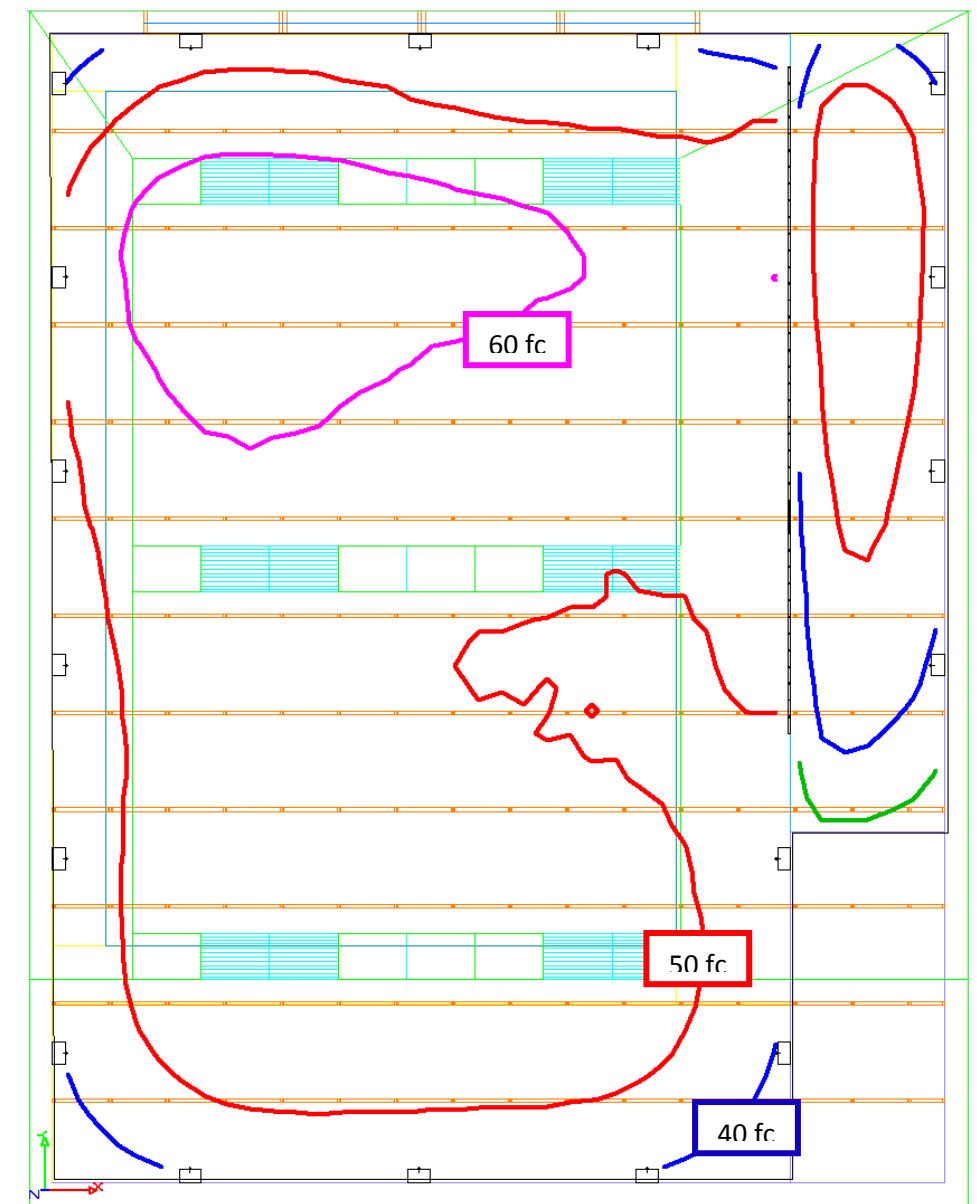
6.4.3 – Pool: AGI32 Calculation of the Combined Electric Lighting and Daylight



Winter Solstice – Cloudy, Noon

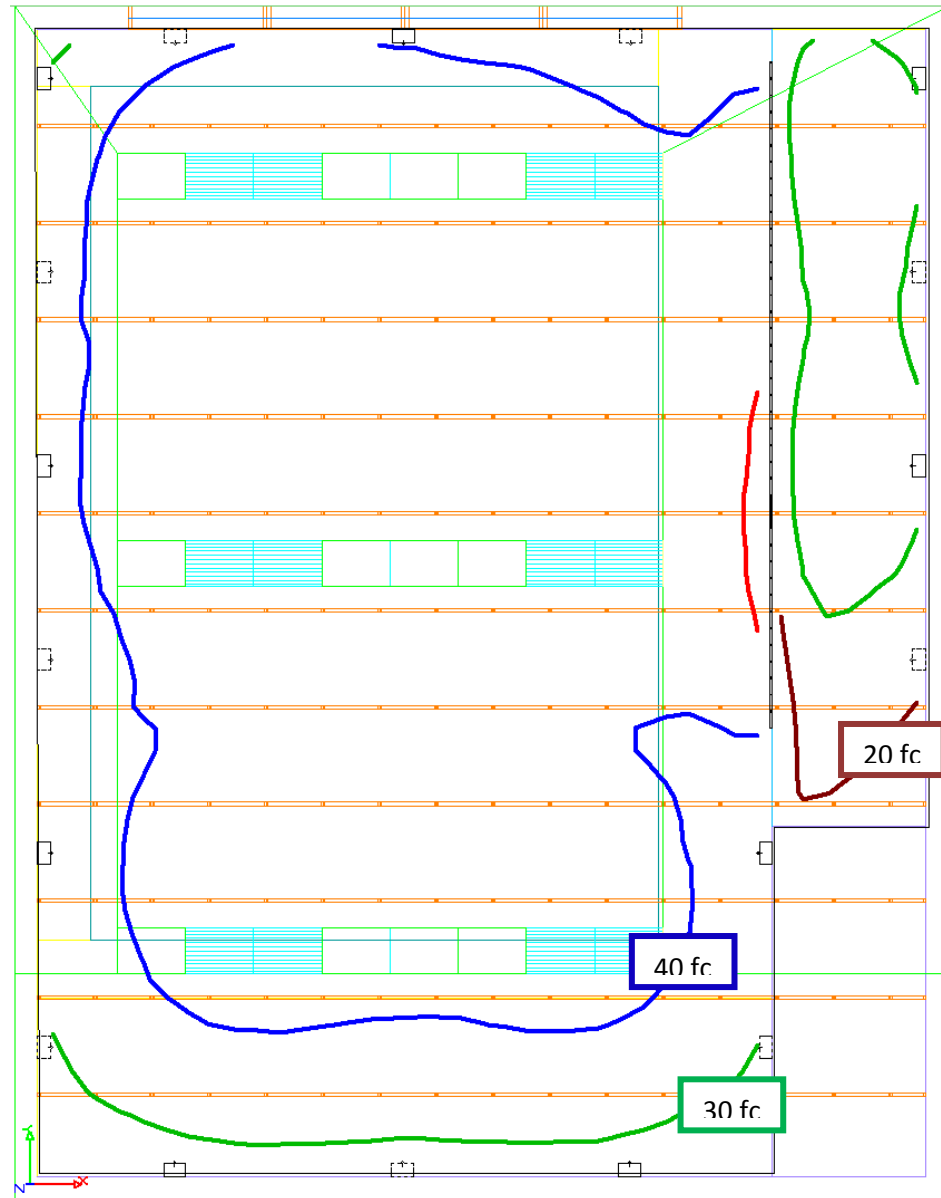


Summer Solstice – Cloudy, Noon

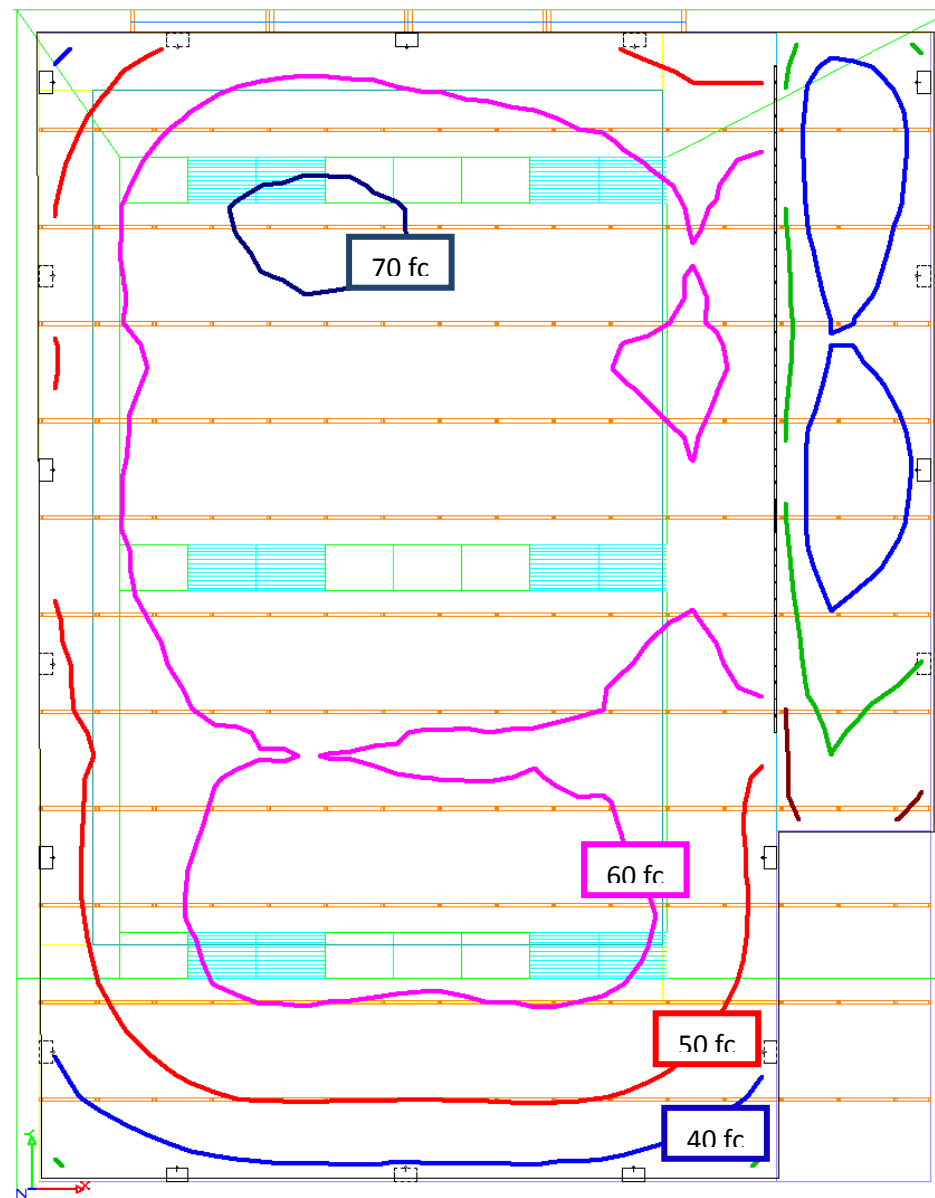


Spring/Fall Equinox – Cloudy, Noon

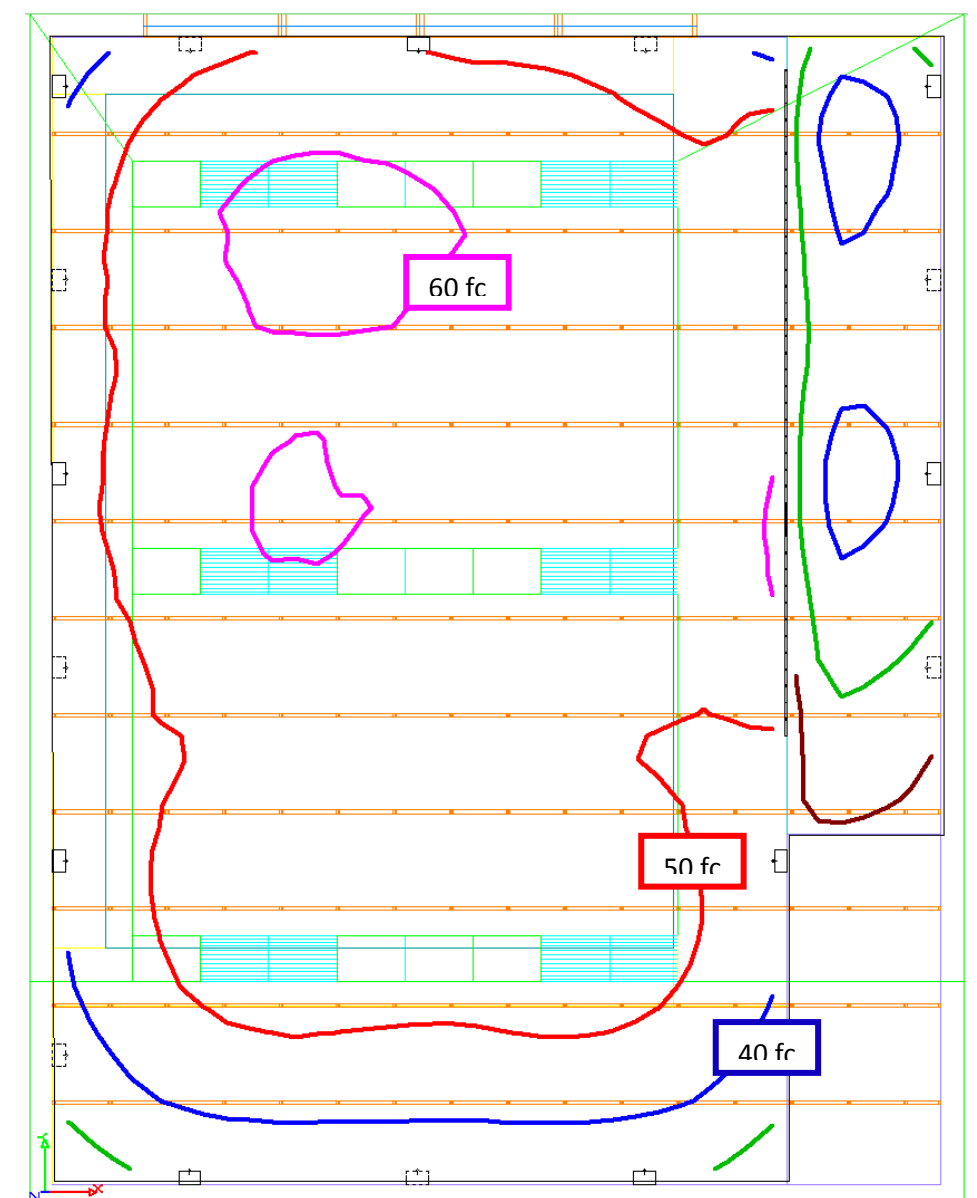
6.4.4 – Pool: AGI Calculation of Daylight with Electric Light at Half-Output



Winter Solstice – Clear Sky, Noon



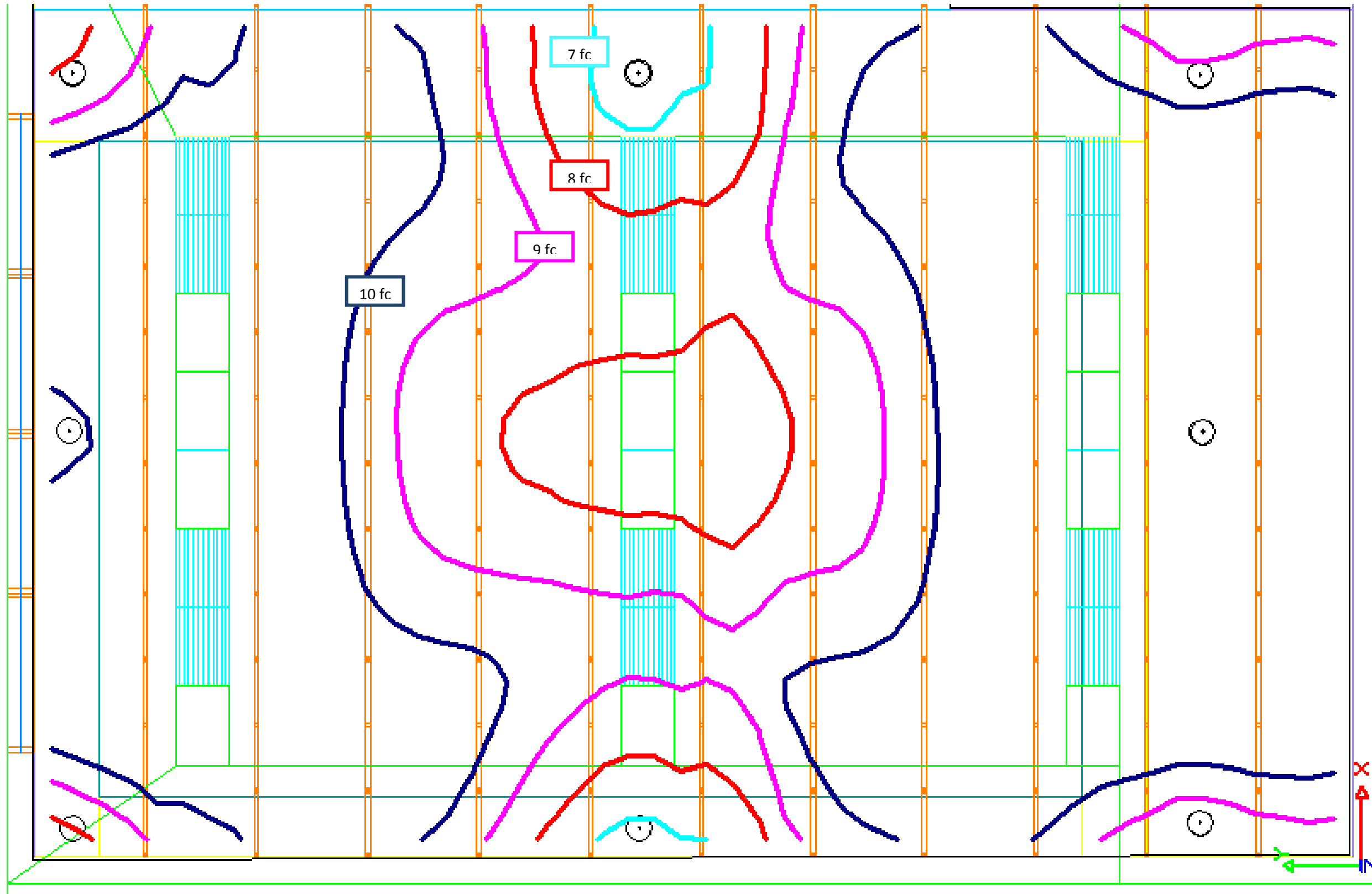
Summer Solstice – Clear Sky, Noon



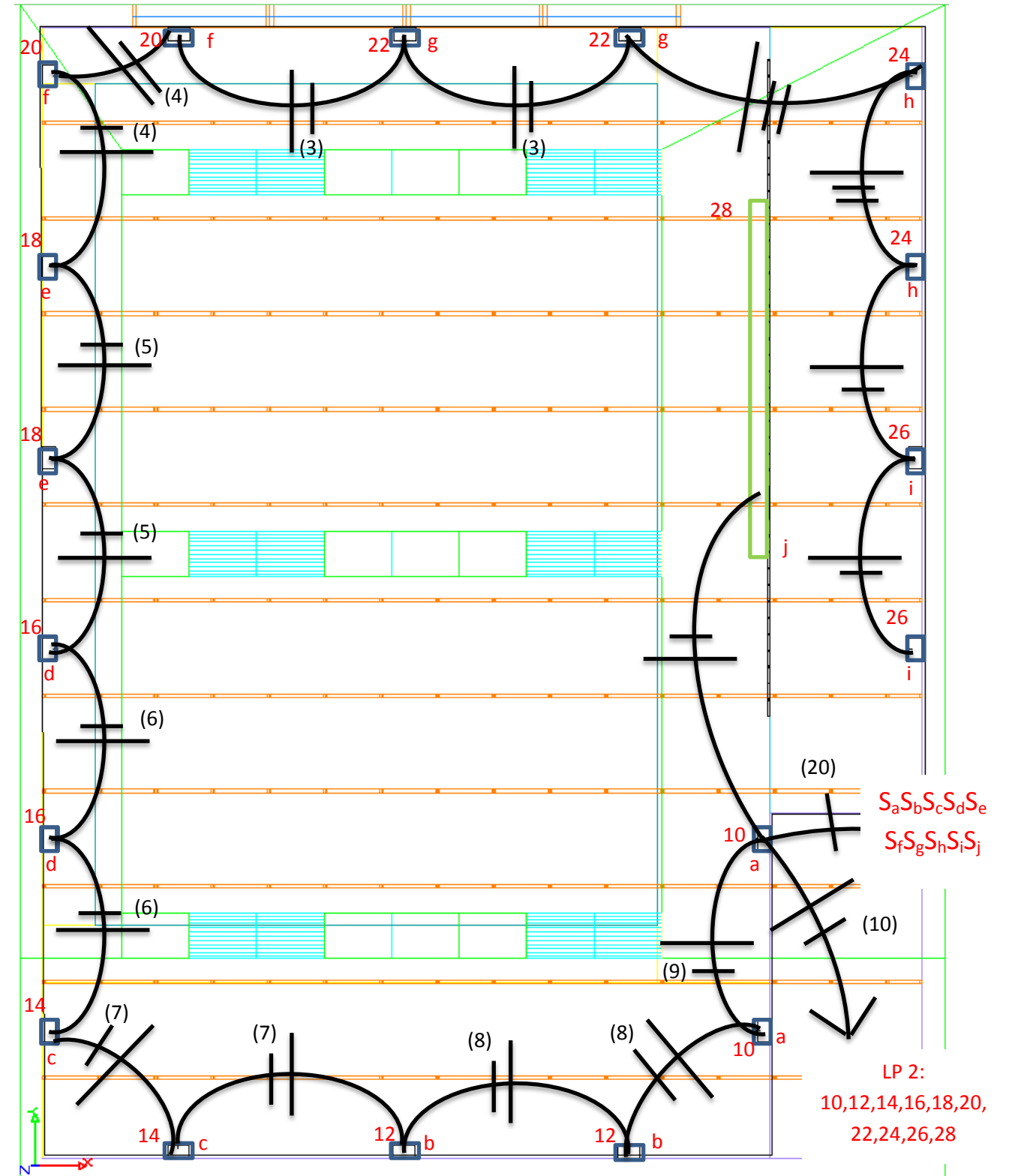
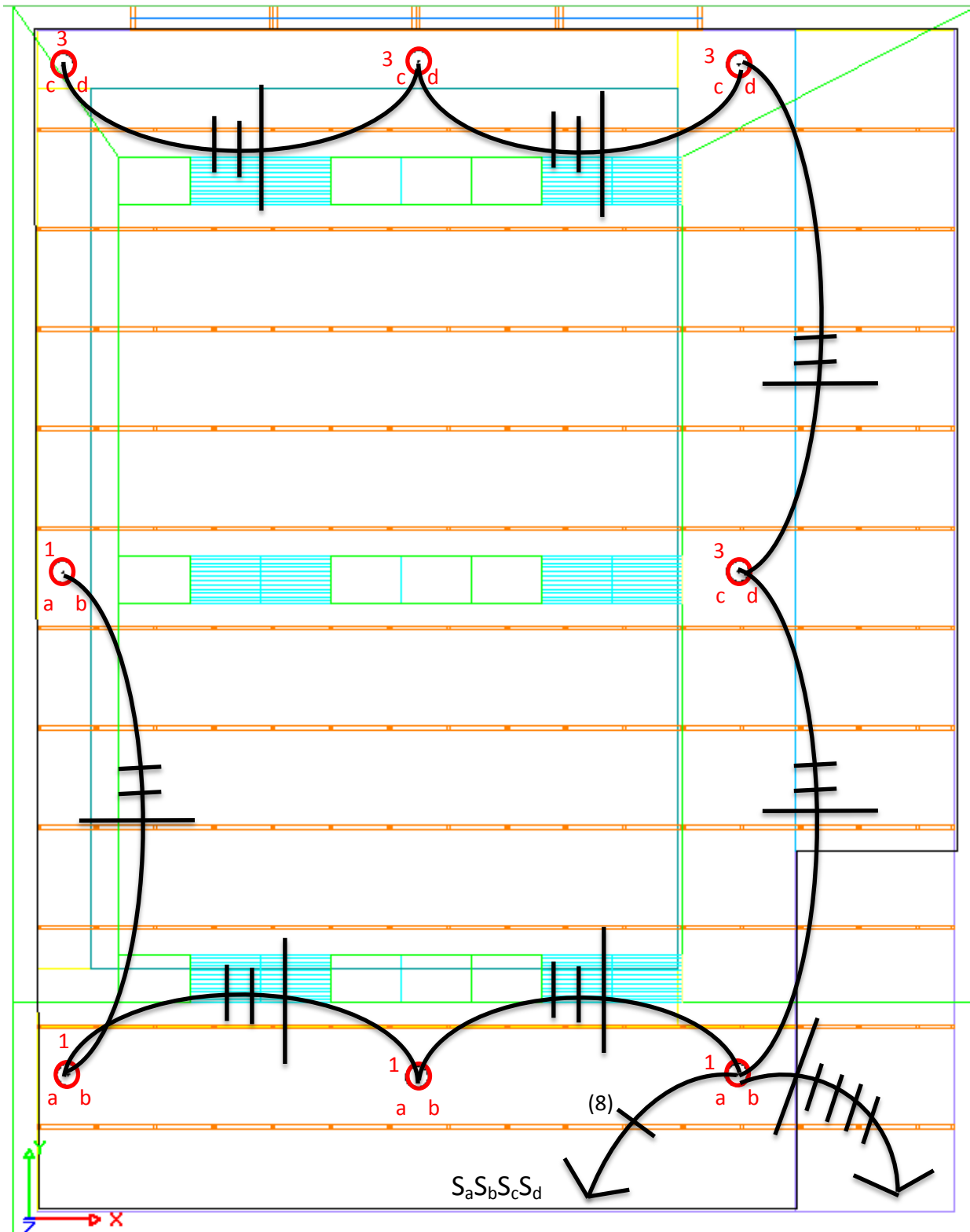
Spring/Fall Equinox – Clear Sky, Noon

NOTE: Lights may be operated at half-output during the day throughout much of the year when there is sufficient daylight in the space. This will allow the school to save money on energy costs.

6.5 – Pool: AGI32 Calculation of Emergency Lighting

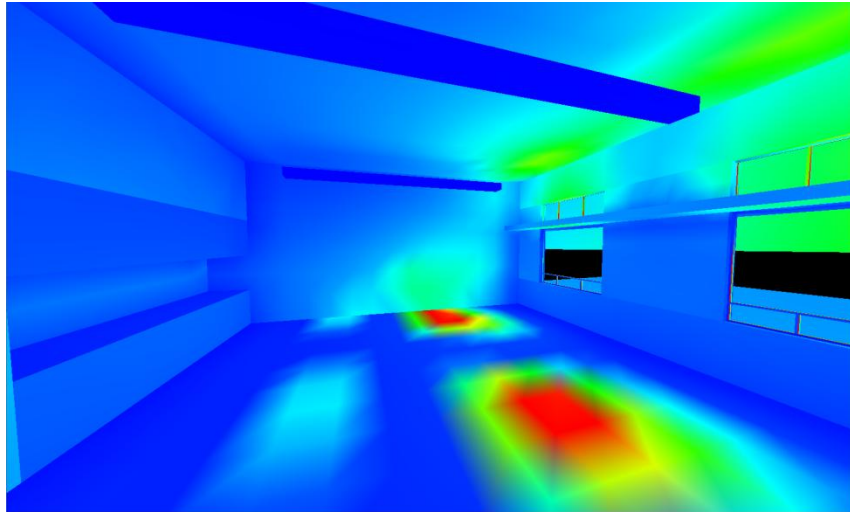


6.6 – Pool: Switching/Wiring Diagrams

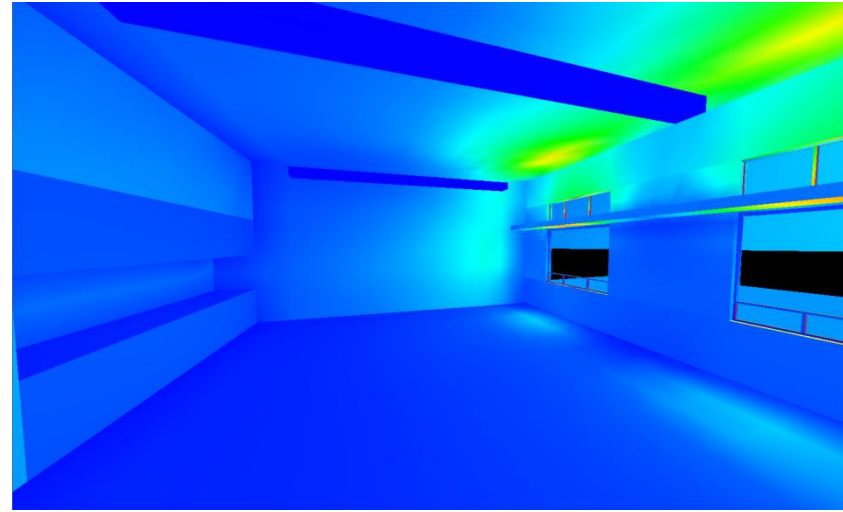


6.7.1 – Classroom: Daylight Analysis – Noon, Clear Sky

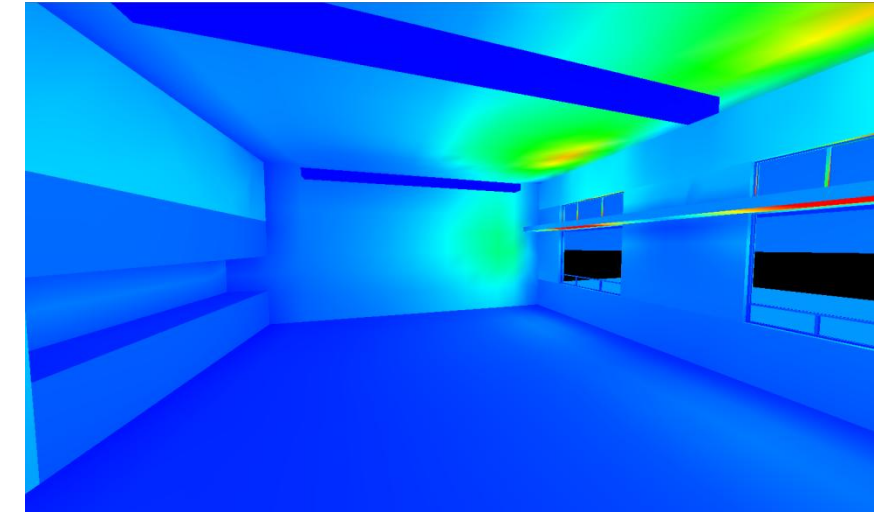
NO SHADES



Winter: Maximum – 1823 fc Average – 287.49 fc

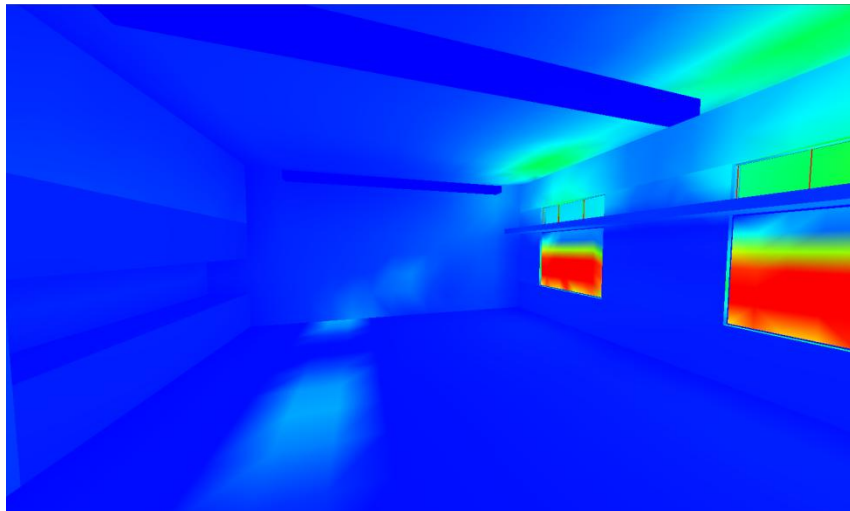


Spring/Fall: Maximum – 191 fc Average – 49.92 fc

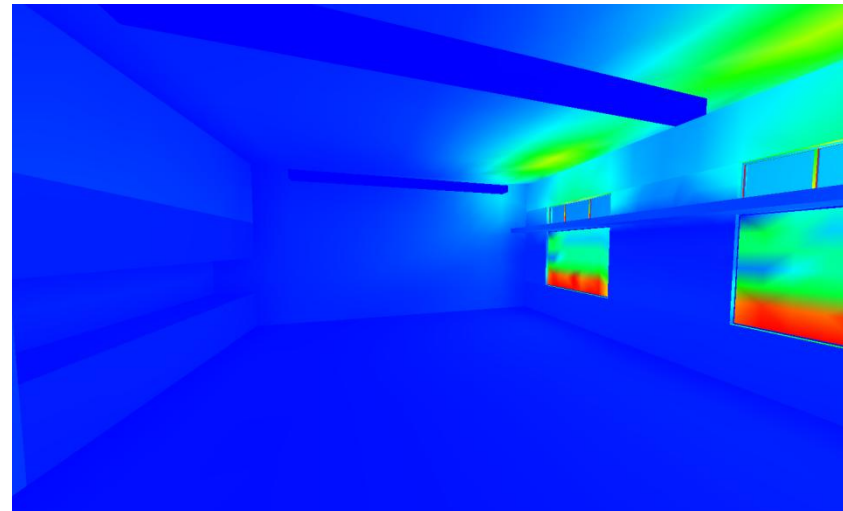


Summer: Maximum – 135 fc Average – 38.29 fc

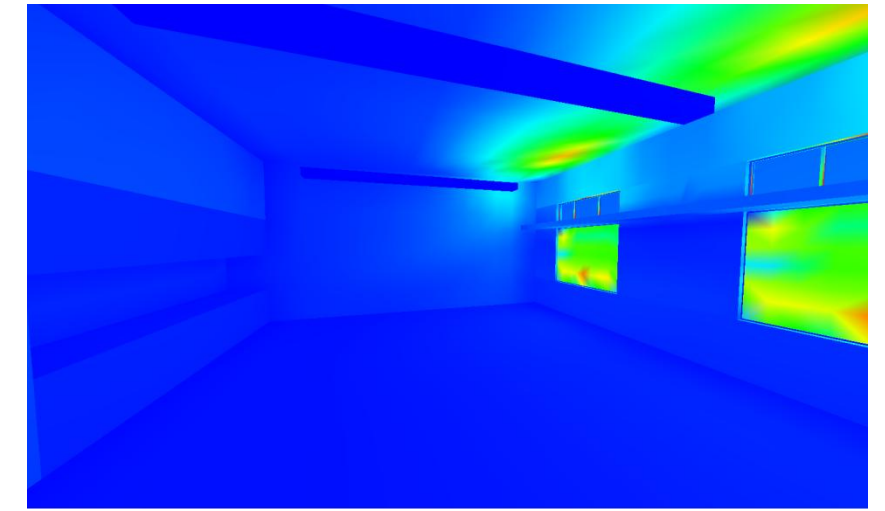
WITH SHADES



Winter: Maximum – 1661 fc Average – 65.05 fc



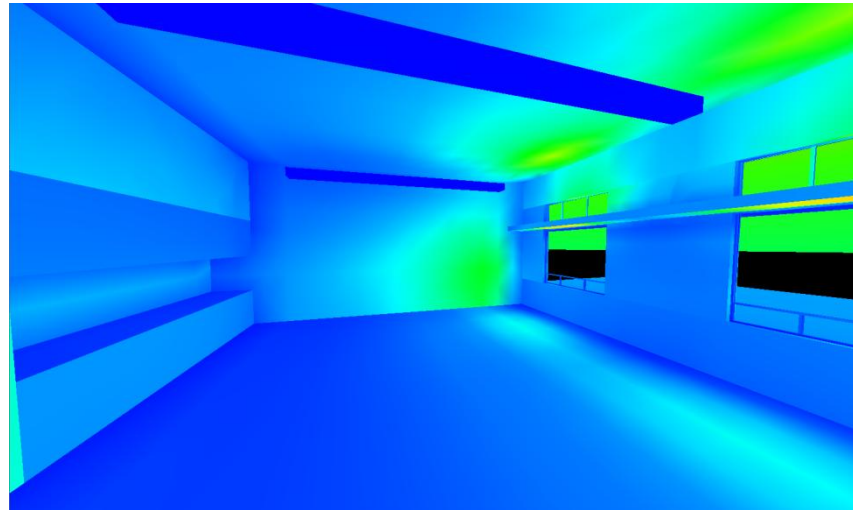
Spring/Fall: Maximum – 60.2 fc Average – 19.04 fc



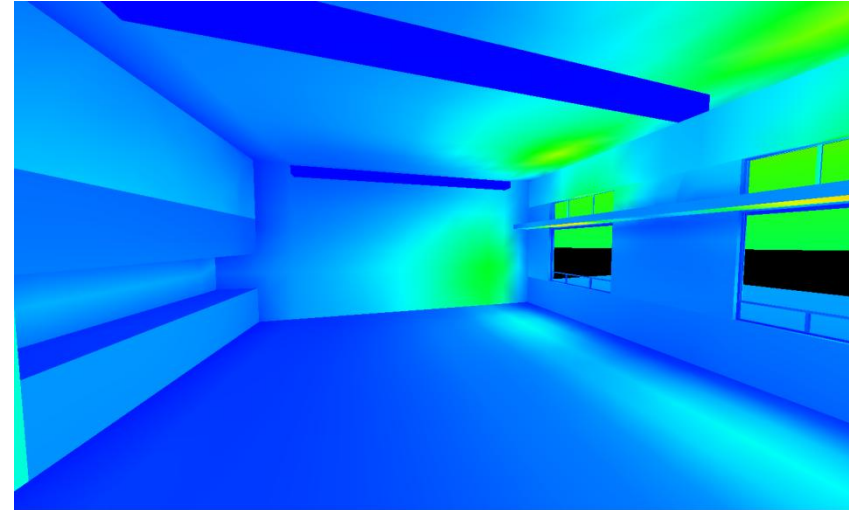
Summer: Maximum – 30.5 fc Average – 12.88 fc

6.7.2 – Classroom: Daylight Analysis – Noon, Cloudy

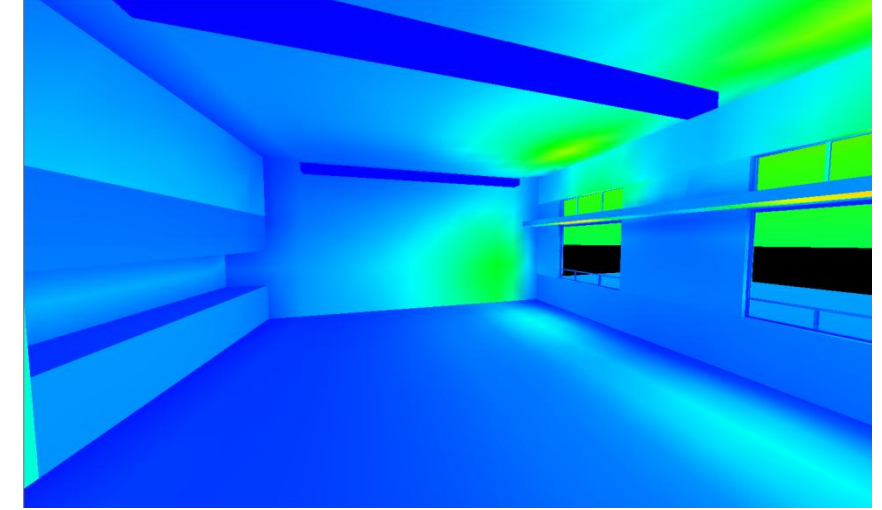
NO SHADES



Winter: Maximum – 43.7 fc Average – 9.10 fc

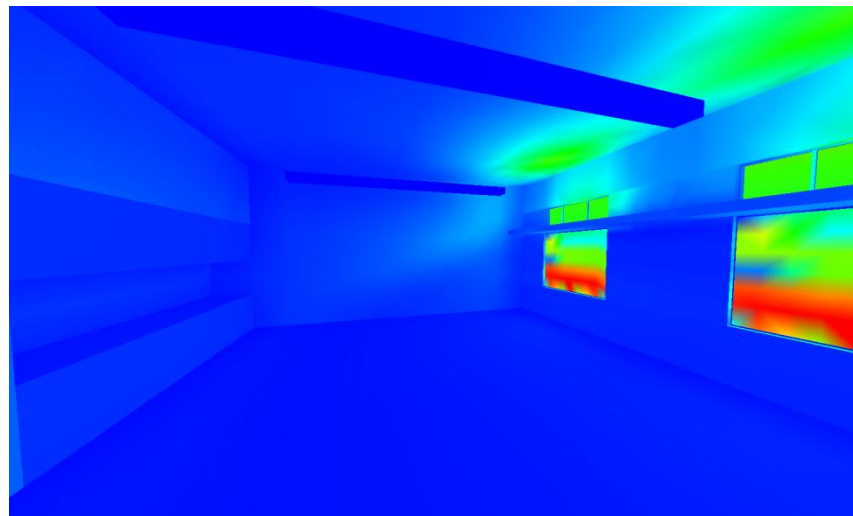


Spring/Fall: Maximum – 73.9 fc Average – 15.38 fc

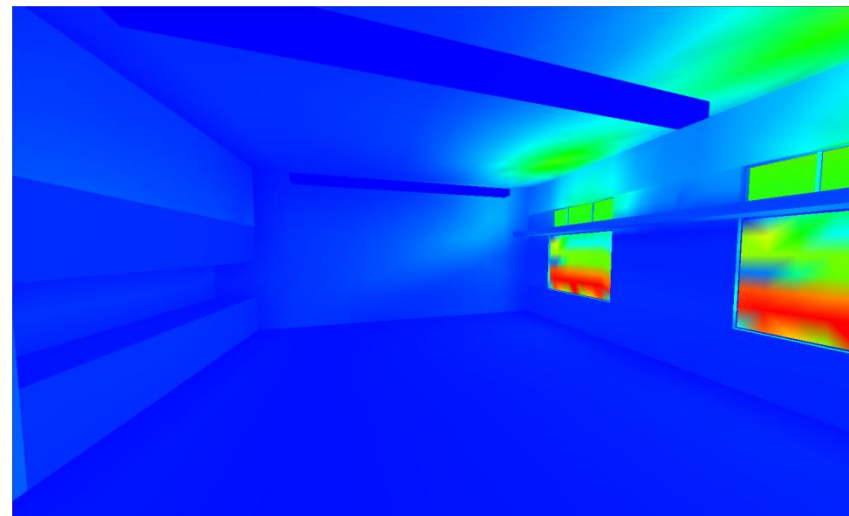


Summer: Maximum – 93 fc Average – 19.36 fc

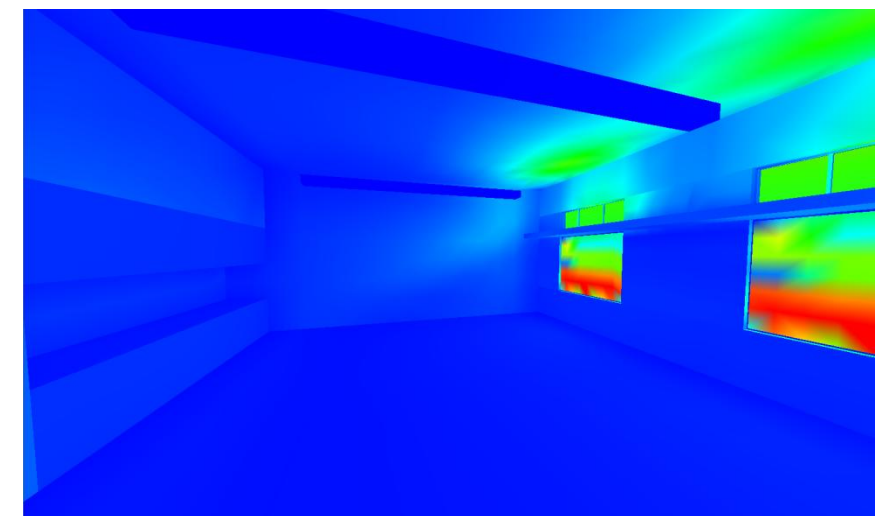
WITH SHADES



Winter: Maximum – 6.1 fc Average – 2.54 fc



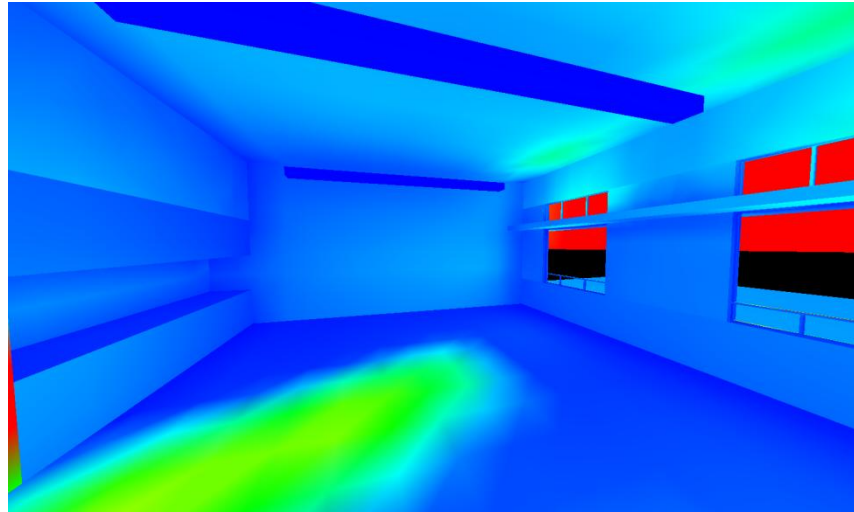
Spring/Fall: Maximum – 10.4 fc Average – 4.30 fc



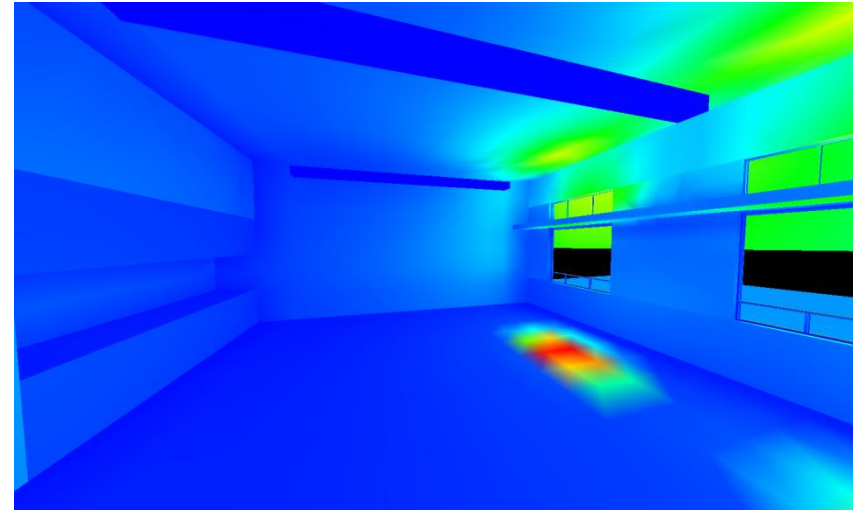
Summer: Maximum – 13.1 fc Average – 5.41 fc

6.7.3 – Classroom: Daylight Analysis – Morning (9 AM), Clear Sky

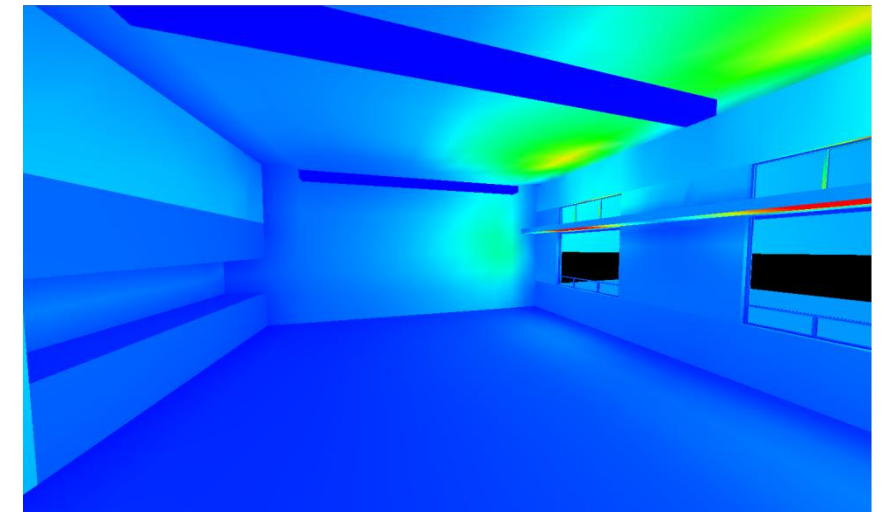
NO SHADES



Winter: Maximum – 805 fc Average – 201 fc

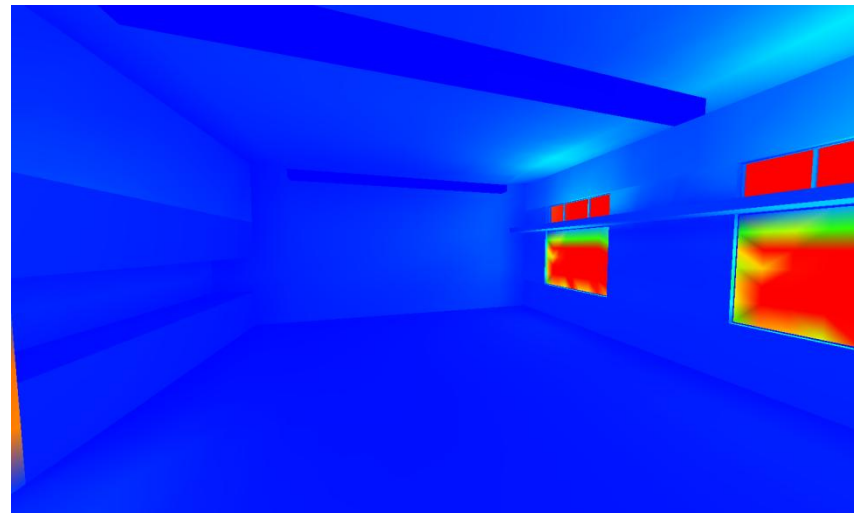


Spring/Fall: Maximum – 2096 fc Average – 138.4 fc

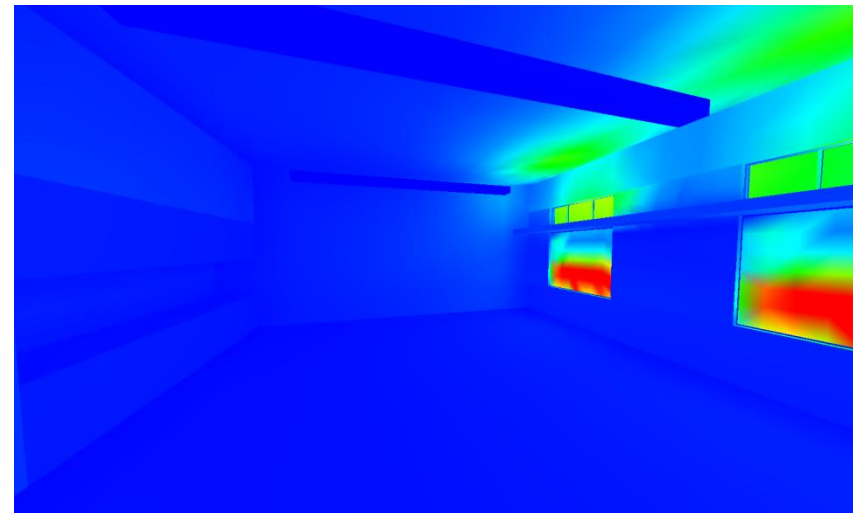


Summer: Maximum – 124 fc Average – 38.48 fc

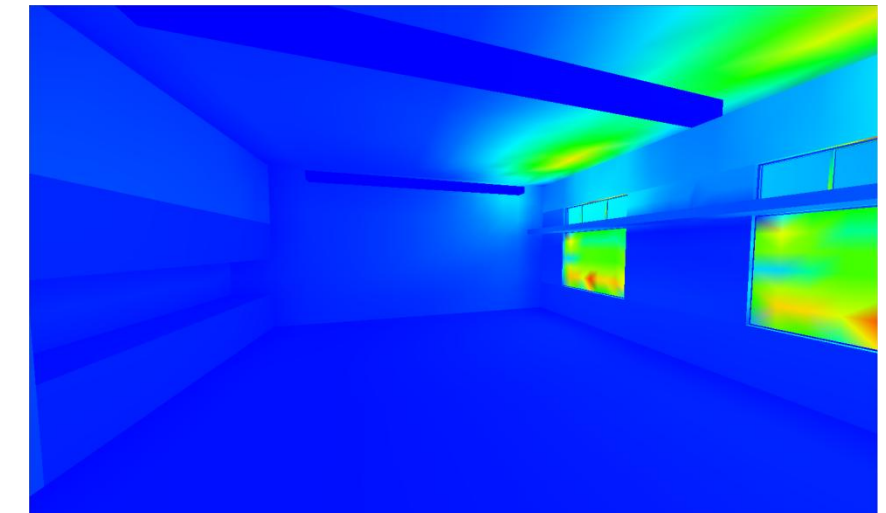
WITH SHADES



Winter: Maximum – 714 fc Average – 30.82 fc



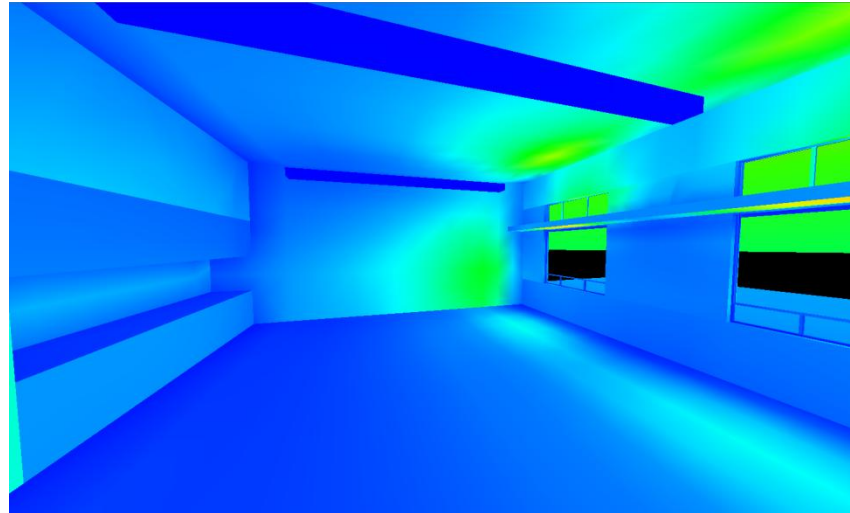
Spring/Fall: Maximum – 86.9 fc Average – 27.29 fc



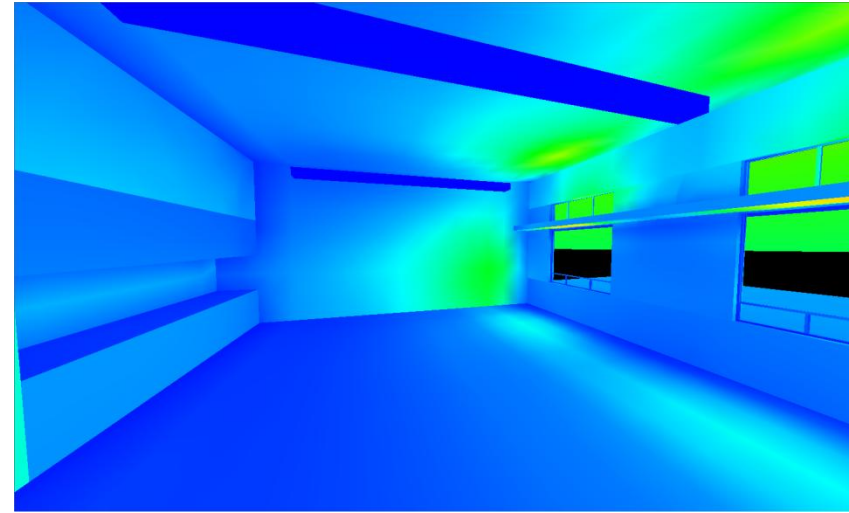
Summer: Maximum – 29.2 fc Average – 13.53 fc

6.7.4 – Classroom: Daylight Analysis – Morning (9 AM), Cloudy

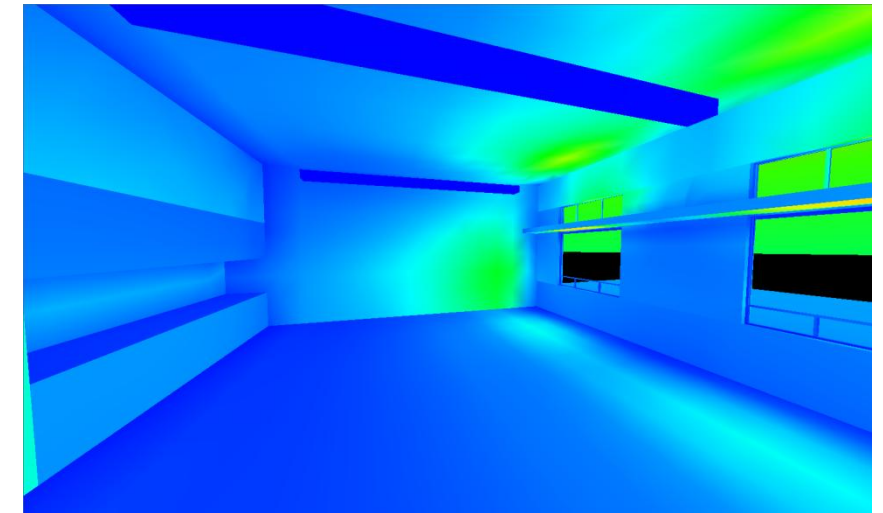
NO SHADES



Winter: Maximum – 23.8 fc Average – 4.95 fc

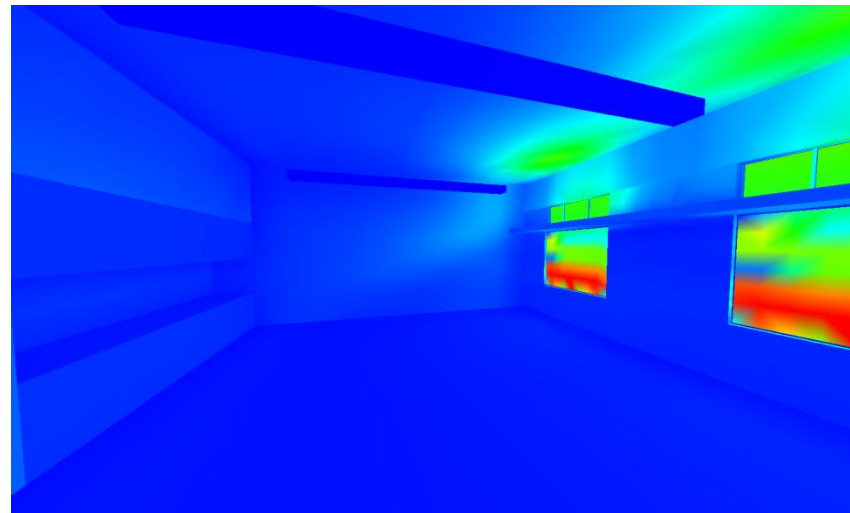


Spring/Fall: Maximum – 50 fc Average – 10.41 fc

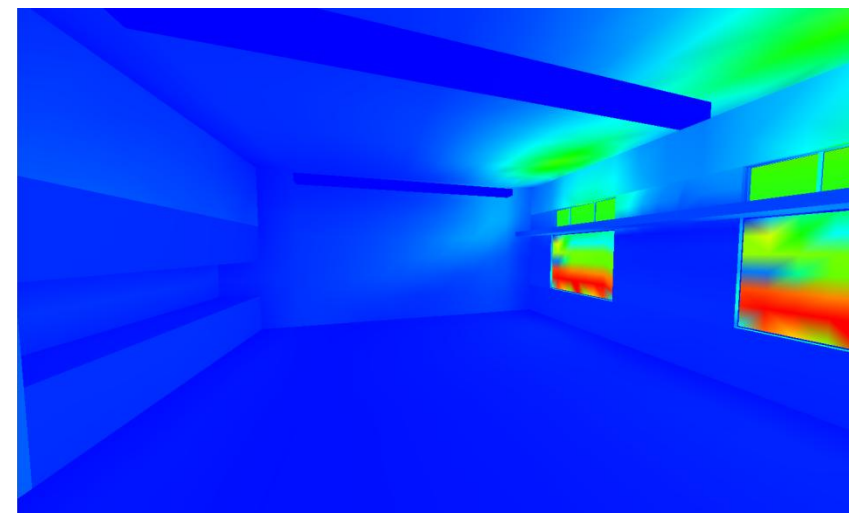


Summer: Maximum – 72.3 fc Average – 15.06 fc

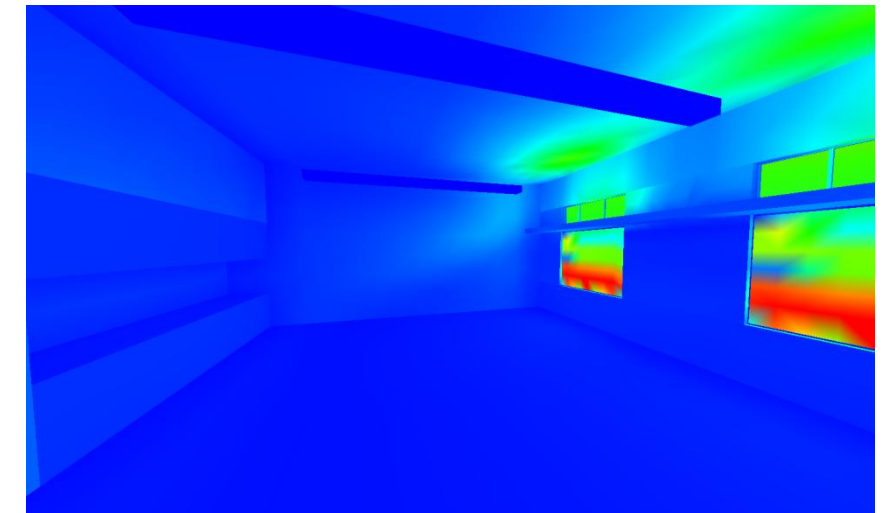
WITH SHADES



Winter: Maximum – 3.3 fc Average – 1.38 fc



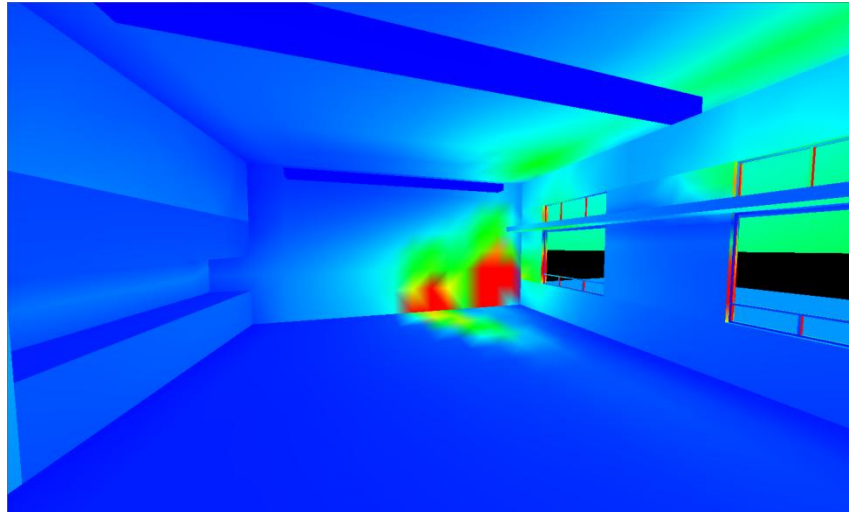
Spring/Fall: Maximum – 7 fc Average – 2.91 fc



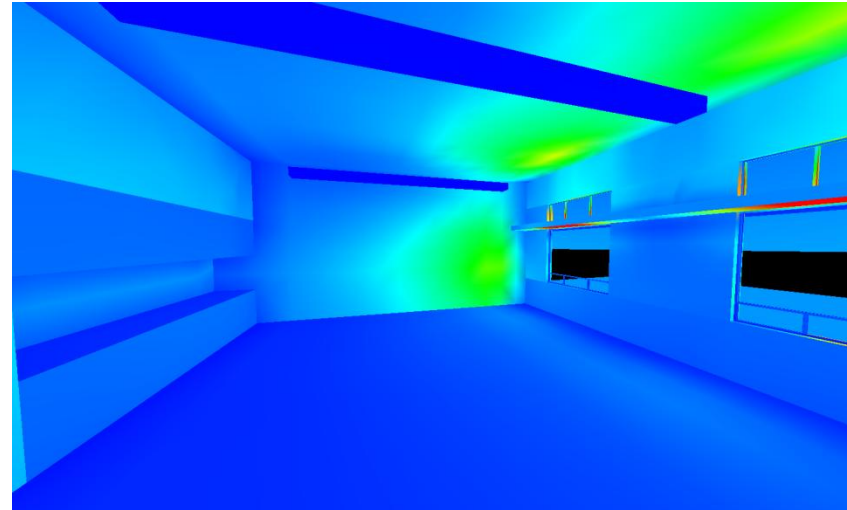
Summer: Maximum – 10.2 fc Average – 4.21 fc

6.7.5 – Classroom: Daylight Analysis – Afternoon (3 PM), Clear Sky

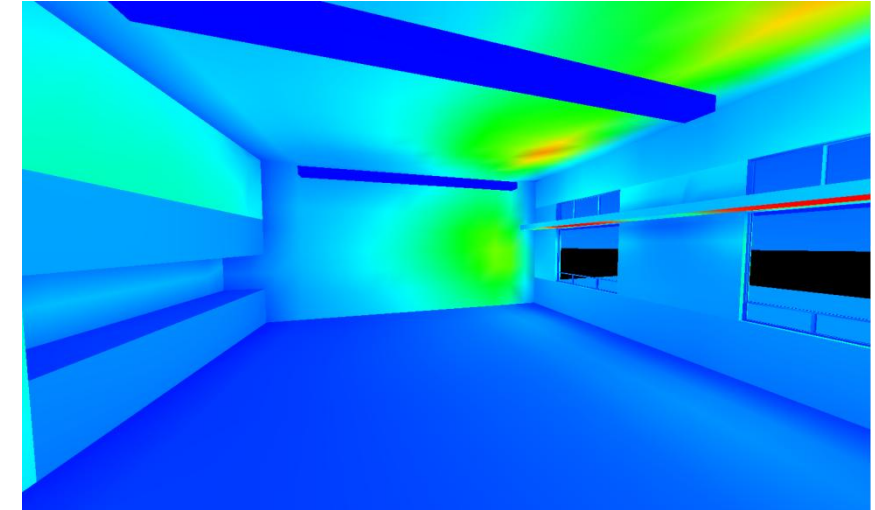
NO SHADES



Winter: Maximum – 803 fc Average – 74.05 fc

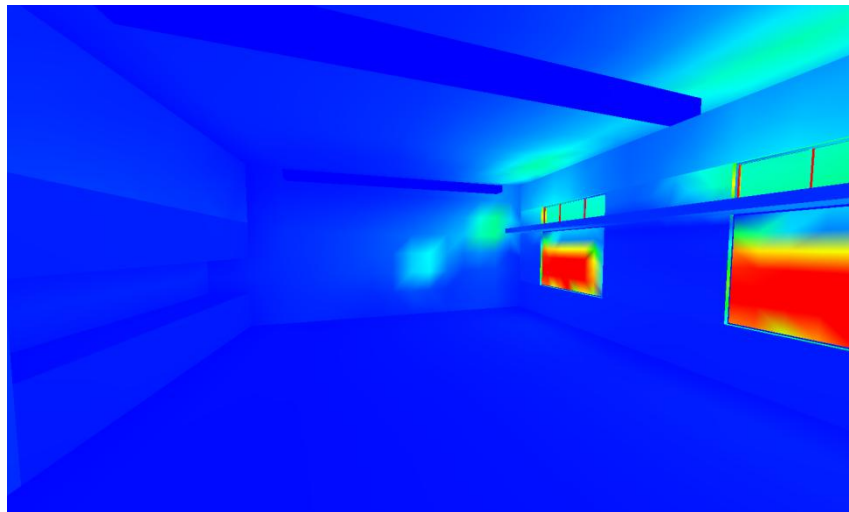


Spring/Fall: Maximum – 108 fc Average – 31.94 fc

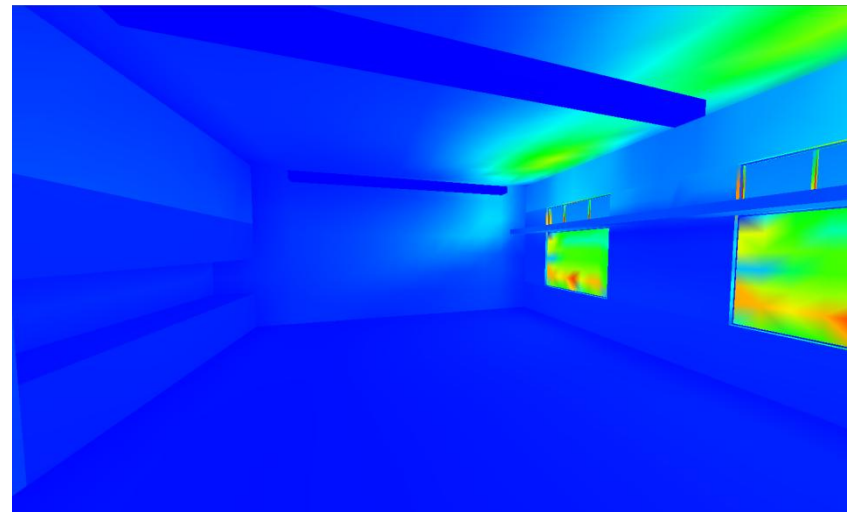


Summer: Maximum – 87.2 fc Average – 28.94 fc

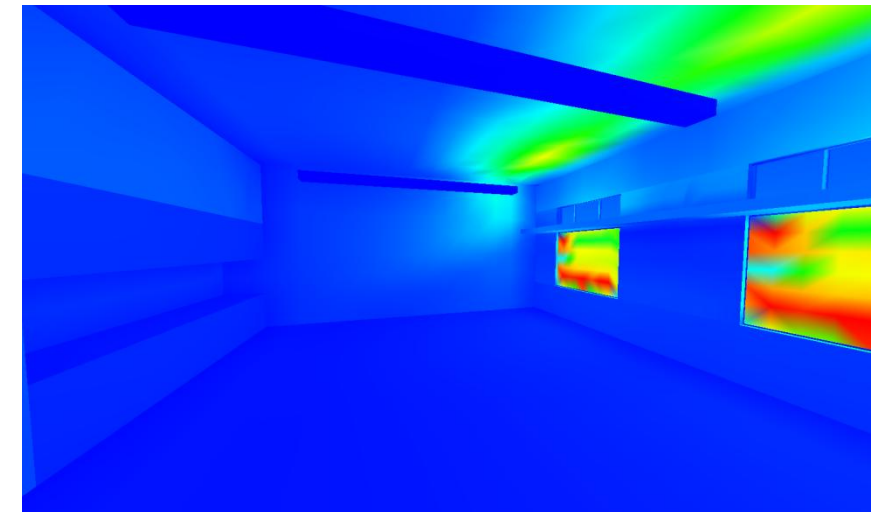
WITH SHADES



Winter: Maximum – 43.4 fc Average – 13.16 fc



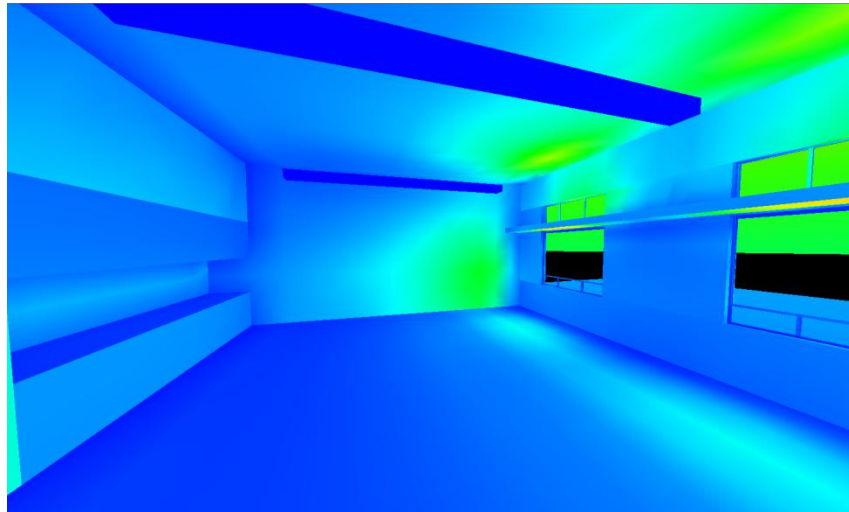
Spring/Fall: Maximum – 25.2 fc Average – 10.75 fc



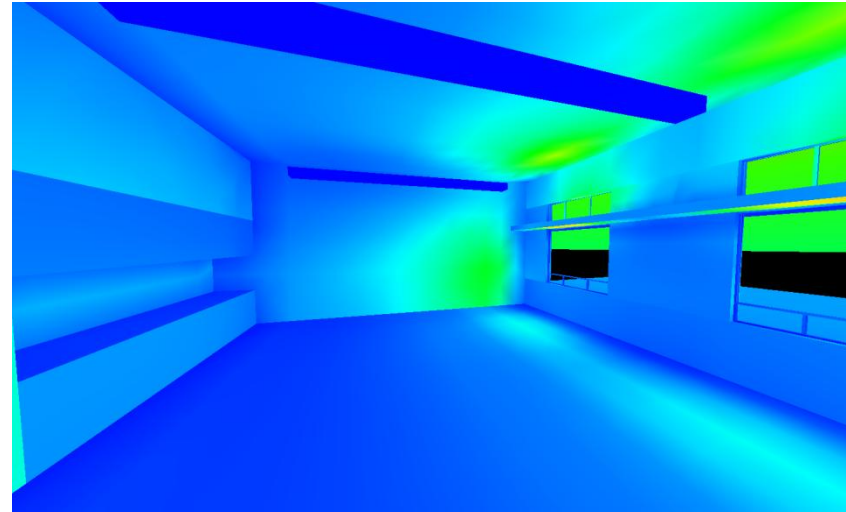
Summer: Maximum – 23.4 fc Average – 10.03 fc

6.7.6 – Classroom: Daylight Analysis – Afternoon (3 PM), Cloudy

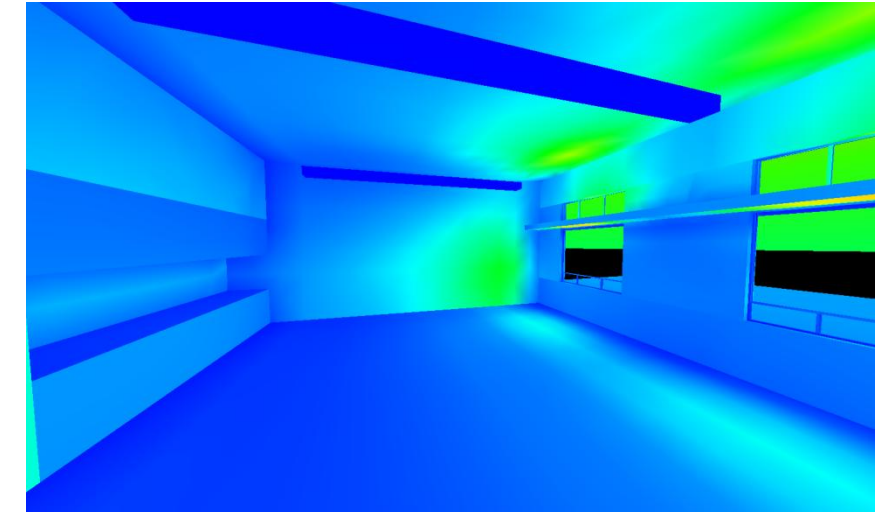
NO SHADES



Winter: Maximum – 24.4 fc Average – 5.07 fc

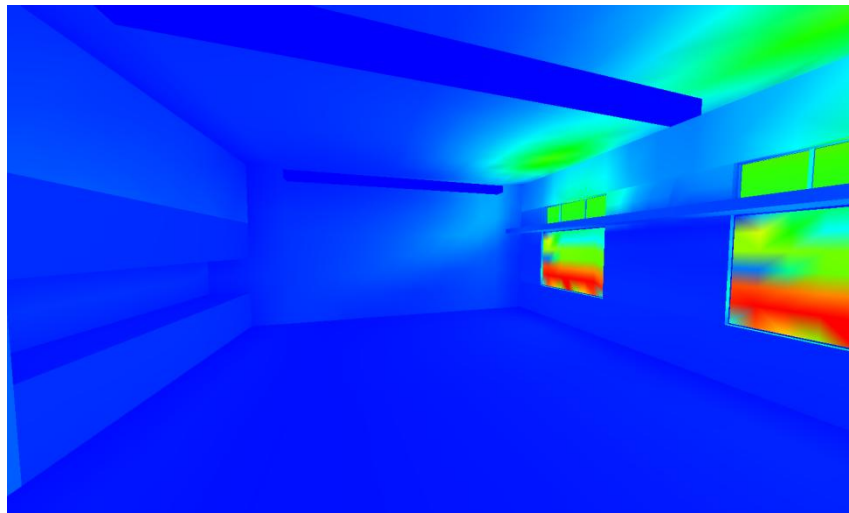


Spring/Fall: Maximum – 55 fc Average – 11.45 fc

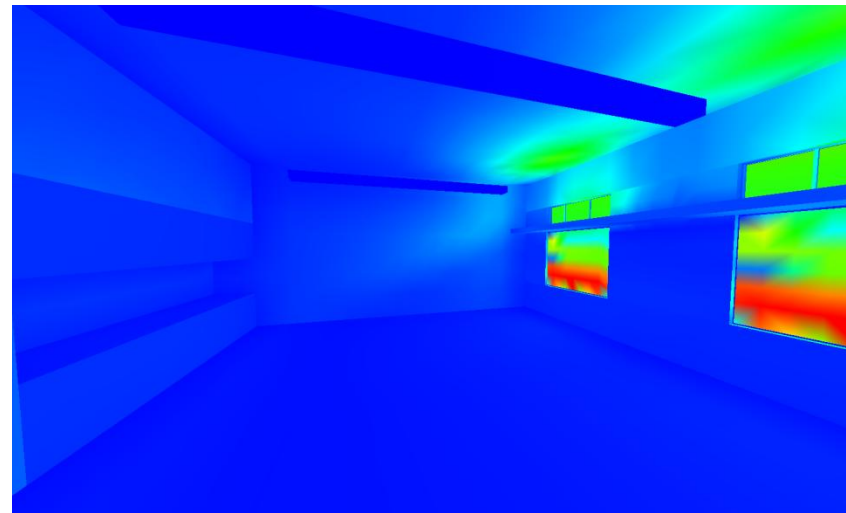


Summer: Maximum – 74.5 fc Average – 15.50 fc

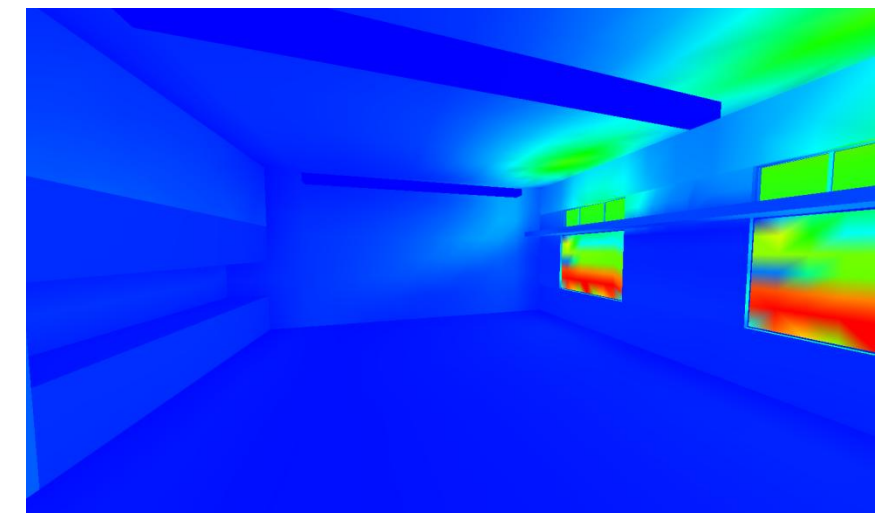
WITH SHADES



Winter: Maximum – 3.4 fc Average – 1.42 fc

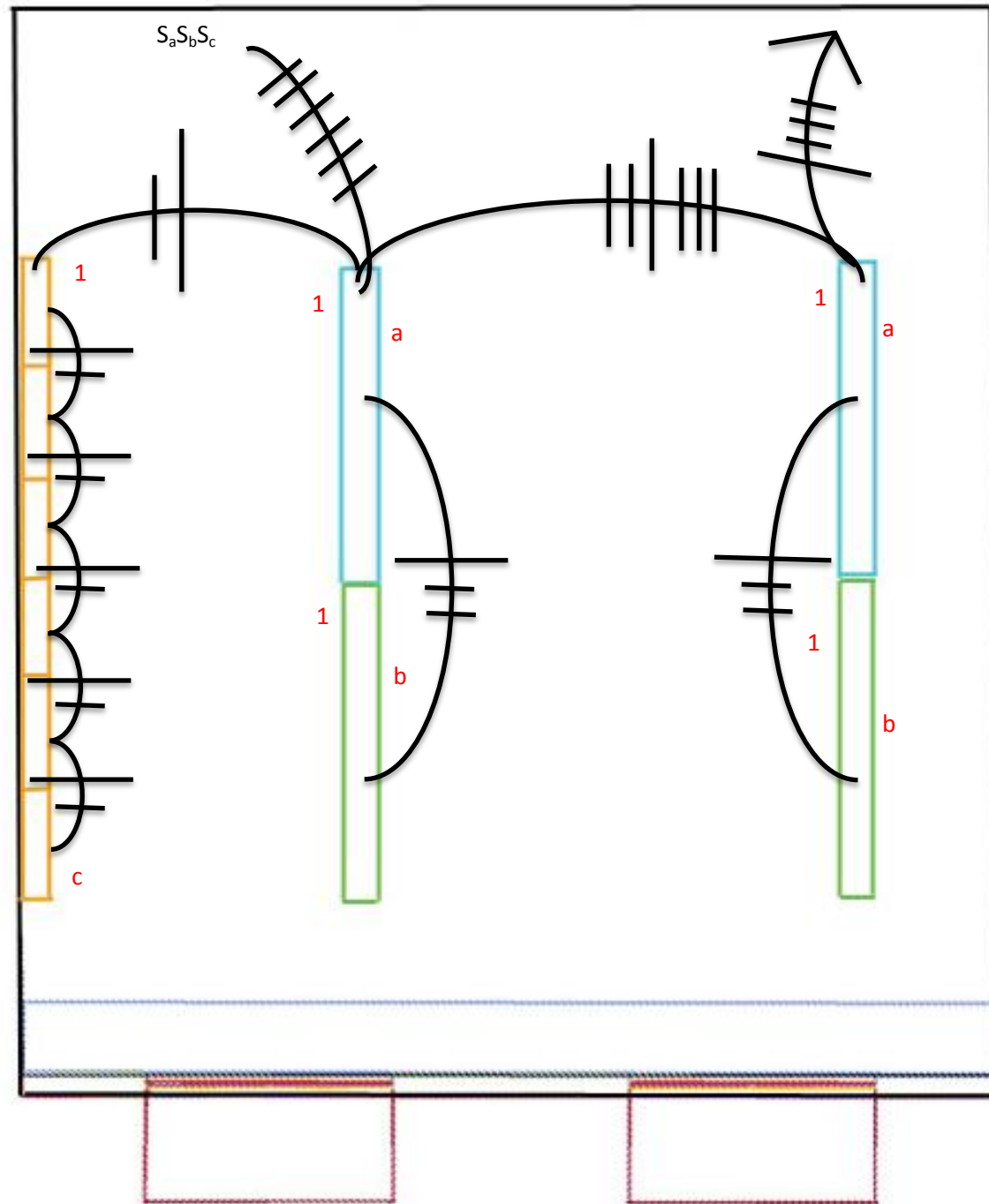


Spring/Fall: Maximum – 7.7 fc Average – 3.20 fc

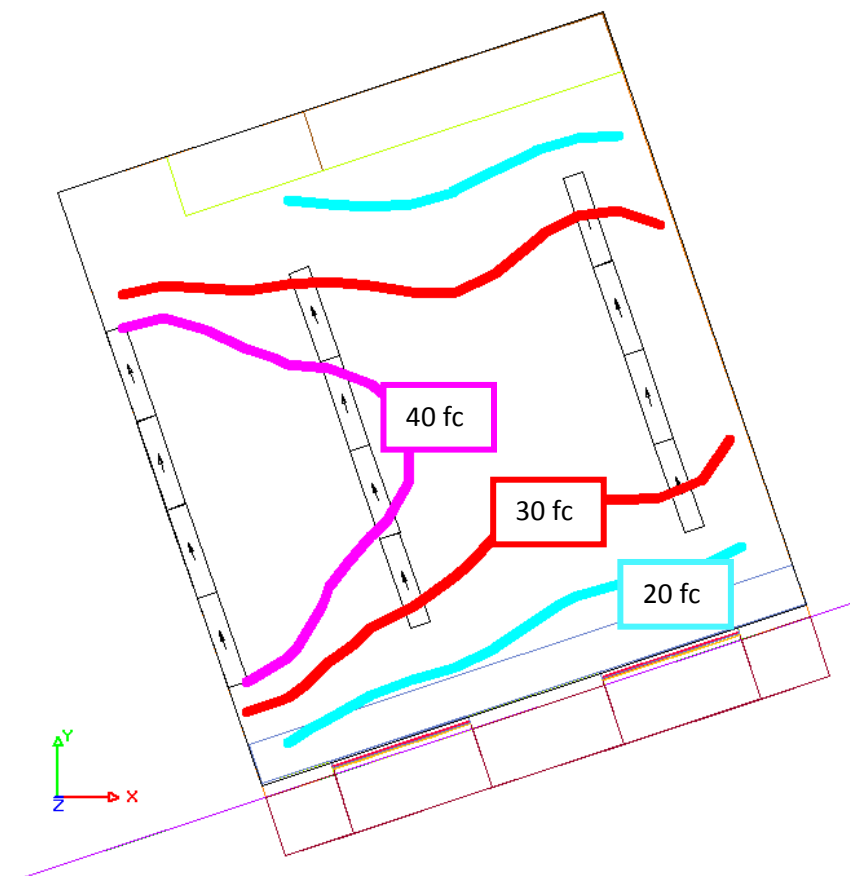


Summer: Maximum – 10.5 fc Average – 4.33 fc

6.8 – Classroom: AGI32 Electric Lighting Calculation and Wiring Diagram



NOTE: All switches will be single-pole to facilitate ease-of-use for the teachers. All controls will be in one central location. The teacher will be able to control all lights in the classroom. He or she will be able to override the light levels set by the photosensor, if the need arises, such as giving a presentation with a projector. The classrooms will also be equipped with occupancy sensors, to turn the lights on when students or staff enter the room. The will also be programmed to turn the lights off when the room is vacant.



Lighting Panel Boards: First and Second Floor

Voltage: 208Y/120 Main Breaker: 125 A Feeder: (4) 1/0

Description	LOAD (VA)			Brk. Trip (A)	LP			LOAD (VA)			Brk. Trip (A)	Description	
	A	B	C		Cond. Size		Cond. Size	A	B	C			
Classrooms 134-136	1881			20	(4) #12	1	2	(4) #12	195			20	Atrium
Classrooms 140-141		1303		20	(4) #12	3	4	(4) #12		1116		20	Atrium
Classrooms 142-143			1303	20	(4) #12	5	6	(4) #12			1725	20	Lobby
Classrooms 144-145	1303			20	(4) #12	7	8						
Classroom 155 and 159-160		1566		20	(4) #12	9	10						
Hallway 149 and 154			1482	20	(4) #12	11	12						
						13	14						
Hallway 103		912		20	(4) #12	15	16						
						17	18						
						19	20						
						21	22						
						23	24						
						25	26						
						27	28						
						29	30						
						31	32						
						33	34						
						35	36						
						37	38						
						39	40						
						41	42						

Total Load on Phase A: 3,379 VA
 Total Load on Phase B: 4,897 VA
 Total Load on Phase C: 4,510 VA
 Total Load on Panel: 13 kVA Demand
106.55 A

Voltage: 208Y/120 Main Breaker: 300 A Feeder: (4) 500

Description	LOAD (VA)			Brk. Trip (A)	LP			LOAD (VA)			Brk. Trip (A)	Description	
	A	B	C		Cond. Size		Cond. Size	A	B	C			
Classrooms 216-218	1881			20	(4) #12	1	2	(4) #12	1360			20	Gym- Zone 1
Classrooms 222-223		1303		20	(4) #12	3	4	(4) #12		1360		20	Gym- Zone 2
Classrooms 224-225			1303	20	(4) #12	5	6	(4) #12			1360	20	Gym- Zone 3
Classrooms 226-227	1303			20	(4) #12	7	8	(4) #12	1360			20	Gym- Zone 4
Classrooms 233-234		1140		20	(4) #12	9	10	(4) #12		1840		20	Pool- Zone 1
Classrooms 235-236			1710	20	(4) #12	11	12	(4) #12			1840	20	Pool- Zone 2
Hallway 214 and 232	1482			20	(4) #12	13	14	(4) #12	1840			20	Pool- Zone 3
Hallway 201		912		20	(4) #12	15	16	(4) #12		1840		20	Pool- Zone 4
Lobby 200			1836	20	(4) #12	17	18	(4) #12			1840	20	Pool- Zone 5
						19	20	(4) #12	1840			20	Pool- Zone 6
						21	22	(4) #12		1840		20	Pool- Zone 7
						23	24	(4) #12			1840	20	Pool- Zone 8
						25	26	(4) #12	1840			20	Pool- Zone 9
						27	28	(4) #12		456		20	Pool- Zone 10
						29	30						
						31	32						
						33	34						
						35	36						
						37	38						
						39	40						
						41	42						

Total Load on Phase A: 12,906 VA
 Total Load on Phase B: 10,691 VA
 Total Load on Phase C: 11,729 VA
 Total Load on Panel: 35 kVA Demand
294.38 A

Lighting Panel Board: Third Floor

Voltage: <u>208Y/120</u> Main Breaker: <u>125</u> A Feeder: <u>(4) 1/0</u>													
Description	LOAD (VA)			Brk. Trip (A)	LP			LOAD (VA)			Brk. Trip (A)	Description	
	A	B	C		Cond. Size		Cond. Size	A	B	C			
Classrooms 317-319	1881			20	(4) #12	1	2						
Classrooms 324-325		1303		20	(4) #14	3	4						
Classrooms 326-327			1303	20	(4) #14	5	6						
Classrooms 328-329	1303			20	(4) #14	7	8						
Classrooms 310-311		1303		20	(4) #14	9	10						
Classrooms 312-314			1881	20	(4) #12	11	12						
Hallway 315	342			20	(4) #14	13	14						
Hallway 301		912		20	(4) #14	15	16						
Lobby 300			1836	20	(4) #12	17	18						
						19	20						
						21	22						
						23	24						
						25	26						
						27	28						
						29	30						
						31	32						
						33	34						
						35	36						
						37	38						
						39	40						
						41	42						
Total Load on Phase A: <u>3,526</u> VA Total Load on Phase B: <u>3,518</u> VA Total Load on Phase C: <u>5,020</u> VA Total Load on Panel: <u>12</u> kVA Demand <u>100.53</u> A													

Receptacle Panel: First Floor

Voltage: <u>208Y/120</u> Main Breaker: <u>600</u> A Feeder: <u>(#, size wire & conduit)</u>													
Description	LOAD (VA)			Brk. Trip (A)	LP			LOAD (VA)			Brk. Trip (A)	Description	
	A	B	C		Cond. Size		Cond. Size	A	B	C			
Room 100-101	1800			15	(4) #14	1	2	(4) #14	1800			15	Room 103
Room 104		1800		15	(4) #14	3	4	(4) #14		1800		15	Room 104
Room 105			1440	15	(4) #14	5	6	(4) #14			1800	15	Room 108 and 110
Room 109 and 111	1800			15	(4) #14	7	8	(4) #14	1260			15	Room 112-113
Room 115-117		720		15	(4) #14	9	10	(4) #14		1800		15	Room 119
Room 120-122			1620	15	(4) #14	11	12	(4) #14			1080	15	Room 124, 126-127
Room 128	1800			15	(4) #14	13	14	(4) #14	720			15	Room 129 and 131
Room 132		1800		15	(4) #14	15	16	(4) #14		1800		15	Room 132
Room 135			1800	15	(4) #14	17	18	(4) #14			1800	15	Room 136
Room 139	1800			15	(4) #14	19	20	(4) #14	1800			15	Room 140
Room 141		1800		15	(4) #14	21	22	(4) #14		1800		15	Room 142
Room 143			1800	15	(4) #14	23	24	(4) #14			1800	15	Room 144
Room 145	1800			15	(4) #14	25	26	(4) #14	720			15	Room 146-148
Room 149		1800		15	(4) #14	27	28	(4) #14		1800		15	Room 150
Room 151-152			1080	15	(4) #14	29	30	(4) #14			1800	15	Room 153
Room 154	1800			15	(4) #14	31	32	(4) #14	1800			15	Room 155
Room 159		1800		15	(4) #14	33	34	(4) #14		1800		15	Room 160
Room 161			1800	15	(4) #14	35	36	(4) #14			1800	15	Room 162
Room 163	1800			15	(4) #14	37	38	(4) #14	1440			15	Room 164-165
						39	40						
						41	42						
Total Load on Phase A: <u>22,140</u> VA Total Load on Phase B: <u>20,520</u> VA Total Load on Phase C: <u>19,620</u> VA Total Load on Panel: <u>62</u> kVA Demand <u>519.00</u> A													

Receptacle Panels: Second and Third Floor

Voltage: <u>208Y/120</u> Main Breaker: <u> </u> A Feeder: <u> </u> (#, size wire & conduit)													
Description	LOAD (VA)			Brk. Trip (A)	LP			LOAD (VA)			Brk. Trip (A)	Description	
	A	B	C		Cond. Size		Cond. Size	A	B	C			
Room 200	1440			15	(4) #14	1	2	(4) #14	1800			15	Room 201
Room 202		900		15	(4) #14	3	4	(4) #14		720		15	Room 203-205
Room 207			1080	15	(4) #14	5	6	(4) #14			1800	15	Room 208
Room 208	1800			15	(4) #14	7	8	(4) #14	900			15	Room 209
Room 212		1800		15	(4) #14	9	10	(4) #14		720		15	Room 213
Room 214			1800	15	(4) #14	11	12	(4) #14			1800	15	Room 215
Room 217	1800			15	(4) #14	13	14	(4) #14	1800			15	Room 218
Room 219 and 221		1080		15	(4) #14	15	16	(4) #14		1800		15	Room 220
Room 222			1800	15	(4) #14	17	18	(4) #14			1800	15	Room 223
Room 224	1800			15	(4) #14	19	20	(4) #14	1800			15	Room 225
Room 226		1800		15	(4) #14	21	22	(4) #14		1800		15	Room 227
Room 228-230			720	15	(4) #14	23	24	(4) #14			1800	15	Room 231
Room 232	1800			15	(4) #14	25	26	(4) #14	1800			15	Room 233
Room 234		1800		15	(4) #14	27	28	(4) #14		1800		15	Room 235
Room 236			1800	15	(4) #14	29	30	(4) #14				15	
						31	32						
						33	34						
						35	36						
						37	38						
						39	40						
						41	42						

Total Load on Phase A: 16,740 VA
 Total Load on Phase B: 14,220 VA
 Total Load on Phase C: 14,400 VA

Total Load on Panel: 45 kVA Demand
378.00 A

Voltage: <u>208Y/120</u> Main Breaker: <u> </u> A Feeder: <u> </u> (#, size wire & conduit)													
Description	LOAD (VA)			Brk. Trip (A)	LP			LOAD (VA)			Brk. Trip (A)	Description	
	A	B	C		Cond. Size		Cond. Size	A	B	C			
Room 300	1440			15	(4) #14	1	2	(4) #14	1800			15	Room 301
Room 302-303		1440		15	(4) #14	3	4	(4) #14		1440		15	Room 304-307
Room 310			1800	15	(4) #14	5	6	(4) #14			1800	15	Room 311
Room 312	1800			15	(4) #14	7	8	(4) #14	1800			15	Room 313
Room 314		1800		15	(4) #14	9	10	(4) #14		1800		15	Room 315
Room 316			1800	15	(4) #14	11	12	(4) #14			1800	15	Room 317
Room 318	1800			15	(4) #14	13	14	(4) #14	1800			15	Room 319
Room 322		180		15	(4) #14	15	16	(4) #14		1800		15	Room 323
Room 324			1800	15	(4) #14	17	18	(4) #14			1800	15	Room 325
Room 326	1800			15	(4) #14	19	20	(4) #14	1800			15	Room 327
Room 328		1800		15	(4) #14	21	22	(4) #14		1800		15	Room 329
Room 330-332			720	15	(4) #14	23	24	(4) #14			1800	15	Room 333
						25	26						
						27	28						
						29	30						
						31	32						
						33	34						
						35	36						
						37	38						
						39	40						
						41	42						

Total Load on Phase A: 14,040 VA
 Total Load on Phase B: 12,060 VA
 Total Load on Phase C: 13,320 VA

Total Load on Panel: 39 kVA Demand
328.50 A

Mechanical Panels

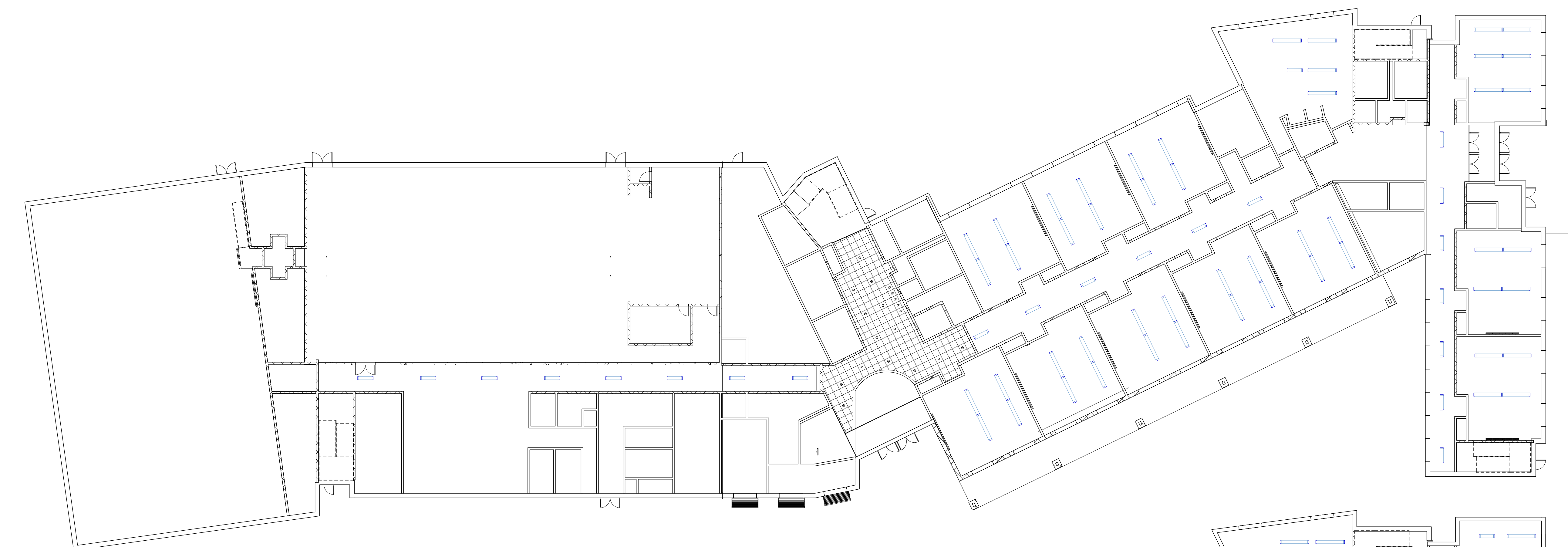
Voltage: <u>480Y/277</u> Main Breaker: <u>2500</u> A Feeder: (#, size wire & conduit)																					
Description	LOAD (VA)			Brk. Trip (A)	LP			LOAD (VA)			Brk. Trip (A)	Description									
	A	B	C		Cond. Size		Cond. Size	A	B	C											
Chiller 1	27133			60	(4) #4	1	2														
		27133		60	(4) #4	3	4														
			27133	60	(4) #4	5	6														
Chiller 2	27133			60	(4) #4	7	8														
		27133		60	(4) #4	9	10														
			27133	60	(4) #4	11	12														
Chiller 3	27133			60	(4) #4	13	14														
		27133		60	(4) #4	15	16														
			27133	60	(4) #4	17	18														
						19	20														
						21	22														
						23	24														
						25	26														
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						37	38														
						39	40														
						41	42														
<table style="width:100%; border:none;"> <tr> <td style="width:33%;">Total Load on Phase A: <u>81,399</u> VA</td> <td style="width:33%;"></td> <td style="width:33%;"></td> </tr> <tr> <td>Total Load on Phase B: <u>81,399</u> VA</td> <td>Total Load on Panel: <u>244</u> kVA Demand</td> <td></td> </tr> <tr> <td>Total Load on Phase C: <u>81,399</u> VA</td> <td><u>2034.98</u> A</td> <td></td> </tr> </table>													Total Load on Phase A: <u>81,399</u> VA			Total Load on Phase B: <u>81,399</u> VA	Total Load on Panel: <u>244</u> kVA Demand		Total Load on Phase C: <u>81,399</u> VA	<u>2034.98</u> A	
Total Load on Phase A: <u>81,399</u> VA																					
Total Load on Phase B: <u>81,399</u> VA	Total Load on Panel: <u>244</u> kVA Demand																				
Total Load on Phase C: <u>81,399</u> VA	<u>2034.98</u> A																				

Voltage: <u>480Y/277</u> Main Breaker: <u>2000</u> A Feeder: (#, size wire & conduit)																					
Description	LOAD (VA)			Brk. Trip (A)	LP			LOAD (VA)			Brk. Trip (A)	Description									
	A	B	C		Cond. Size		Cond. Size	A	B	C											
Air-handling Unit 1	14400			35	(4) #8	1	2														
		14400		35	(4) #8	3	4														
			14400	35	(4) #8	5	6														
Air-handling Unit 2	30560			70	(4) #4	7	8														
		30560		70	(4) #4	9	10														
			30560	70	(4) #4	11	12														
Air-handling Unit 3	28960			70	(4) #4	13	14														
		28960		70	(4) #4	15	16														
			28960	70	(4) #4	17	18														
						19	20														
						21	22														
						23	24														
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						37	38														
						39	40														
						41	42														
<table style="width:100%; border:none;"> <tr> <td style="width:33%;">Total Load on Phase A: <u>73,920</u> VA</td> <td style="width:33%;"></td> <td style="width:33%;"></td> </tr> <tr> <td>Total Load on Phase B: <u>73,920</u> VA</td> <td>Total Load on Panel: <u>222</u> kVA Demand</td> <td></td> </tr> <tr> <td>Total Load on Phase C: <u>73,920</u> VA</td> <td><u>1848.00</u> A</td> <td></td> </tr> </table>													Total Load on Phase A: <u>73,920</u> VA			Total Load on Phase B: <u>73,920</u> VA	Total Load on Panel: <u>222</u> kVA Demand		Total Load on Phase C: <u>73,920</u> VA	<u>1848.00</u> A	
Total Load on Phase A: <u>73,920</u> VA																					
Total Load on Phase B: <u>73,920</u> VA	Total Load on Panel: <u>222</u> kVA Demand																				
Total Load on Phase C: <u>73,920</u> VA	<u>1848.00</u> A																				

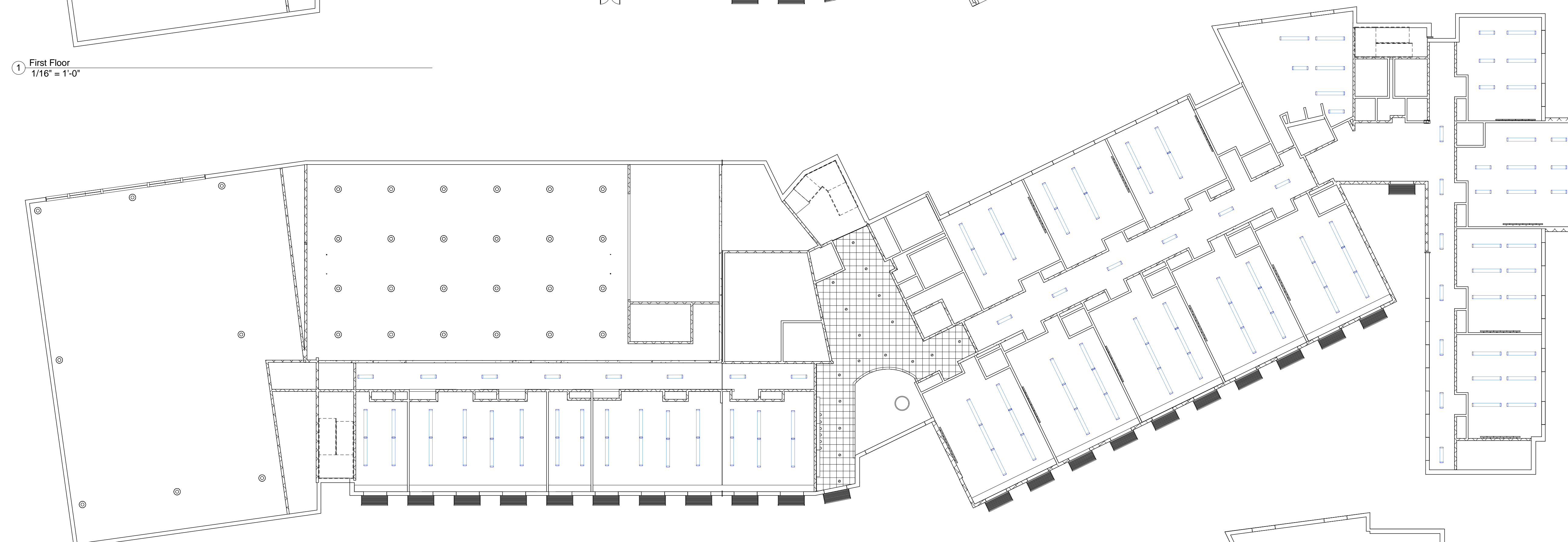


BUILDING INTEGRATION

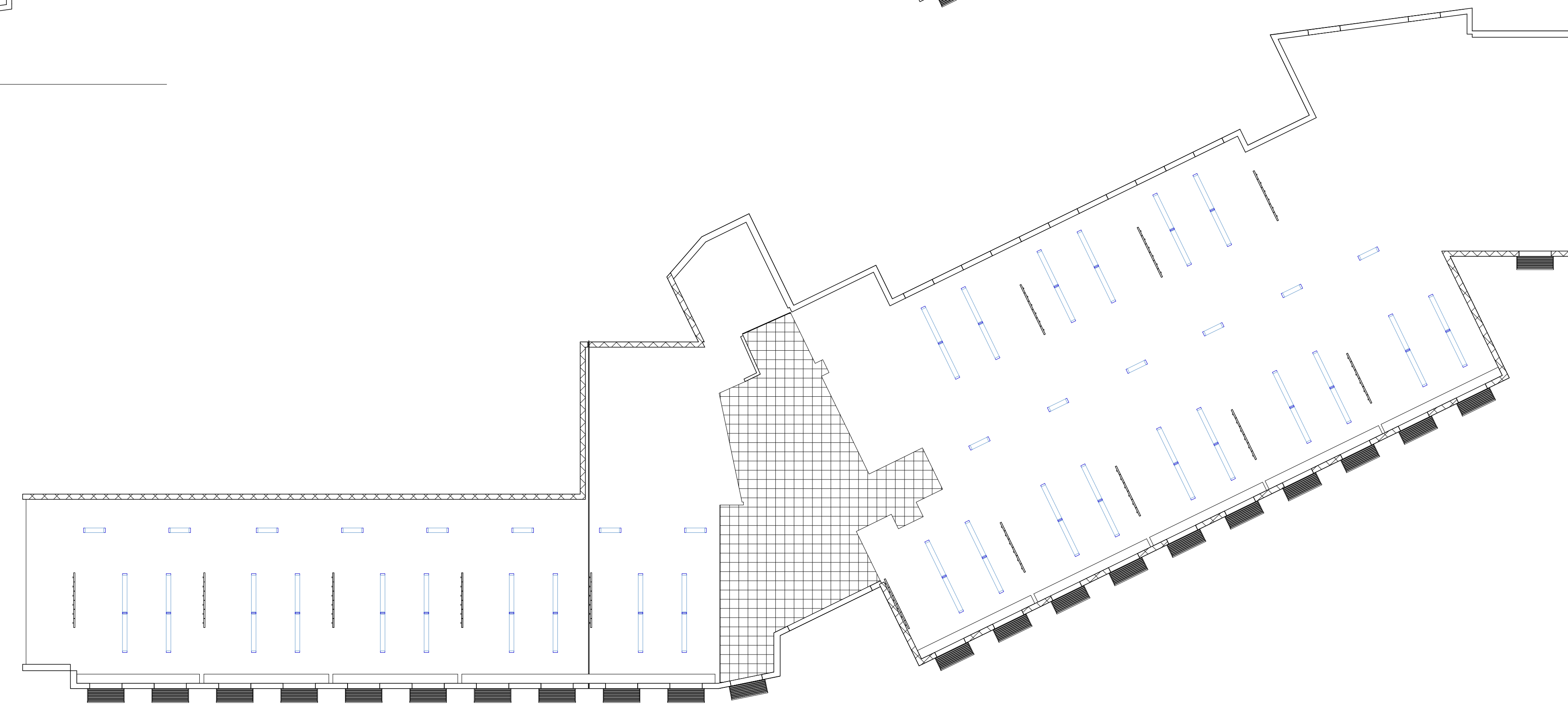
2013 ASCE Charles Pankow Foundation Annual Architectural Engineering Student Competition



① First Floor
1/16" = 1'-0"



② Second Floor
1/16" = 1'-0"



③ Third Floor
1/16" = 1'-0"

To ensure ease of maintenance, all fixtures in the classrooms and corridors will use the same T5 lamp. The lobby on all three floors will use compact fluorescent lamps for general illumination, as well as for wallwashing. Luminaire layout for the classrooms and corridors was coordinated with the structural and mechanical teams to ensure no clashing between the systems.

Team Registration Number:
02-2013

Lighting/Electrical Engineering

Date 22 February 2013

45

Scale 1/16" = 1'-0"