

State College Area School District  
Ferguson Township Elementary School  
**Preliminary Daylight Analysis**  
**October 1, 2009**



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## Summary

The purpose of this analysis is to determine the daylight performance of the design as of September 2009 and to provide performance recommendations.

The target performance goal of the project is to achieve an average DAR of at least 45% in all core learning spaces and 80% in the gymnasium. The minimum illuminance value for determining the DAR for the core learning spaces is 35fc and 30fc for the gymnasium.

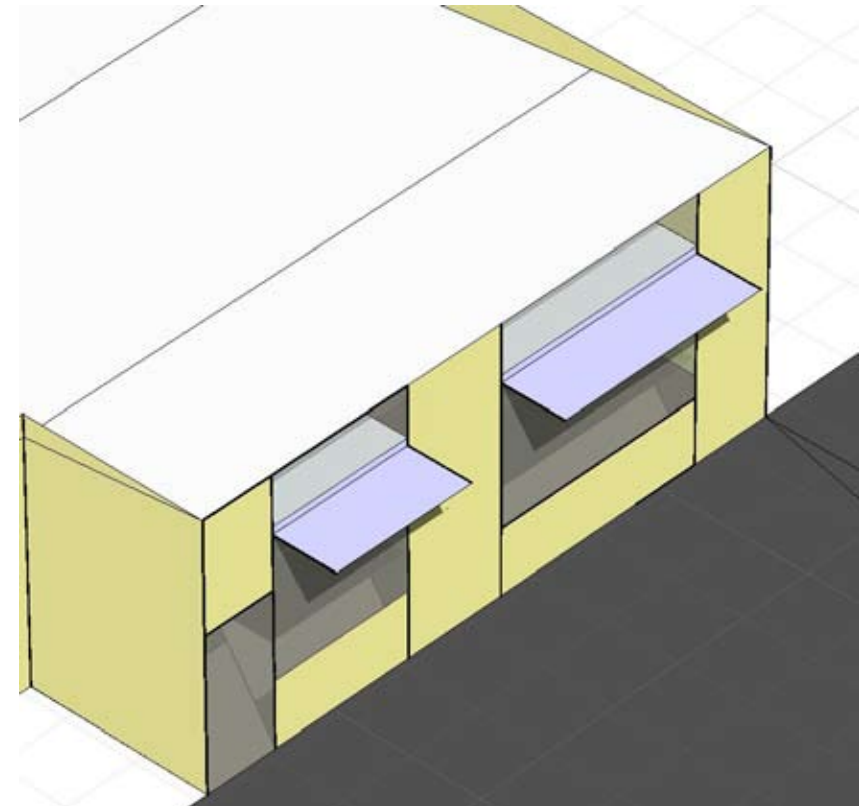
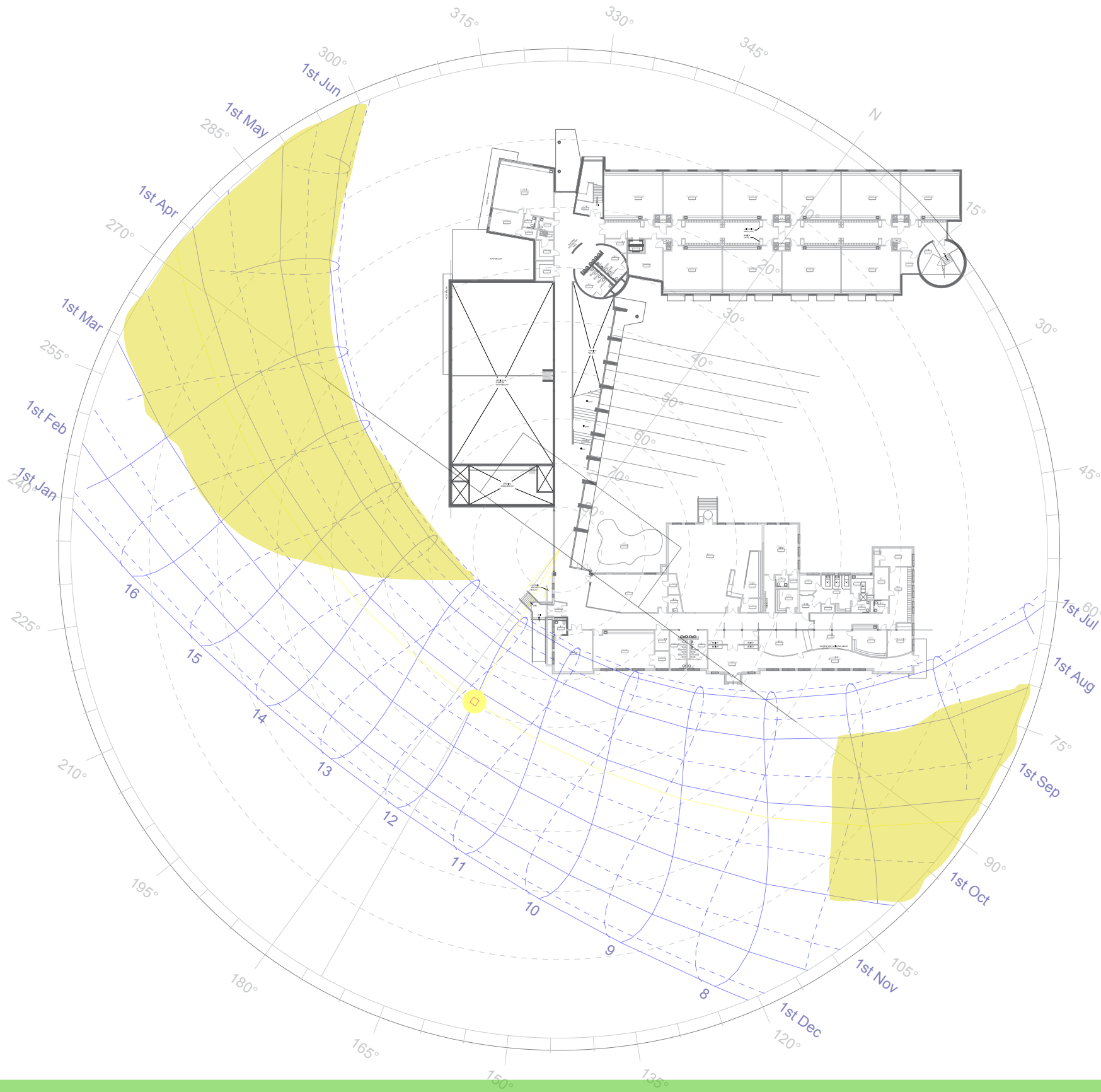
The direct solar component is examined to determine the effectiveness of the exterior shading devices and to identify times and conditions in which direct solar penetration will cause a problem.

The daylight performance of the project should meet the target illuminance goals under the worst case scenario. State College PA, has twice as many days that are cloudy and with some type of cloud cover as it does clear days. The days with cloud cover occur mostly during the school year. Even with that being the case, the clear sky conditions still must be considered.

Internal reflectances, glazing properties, and material geometries are identified in the space specific sections of the report.

This information needs to be shared with all members of the design team to ensure that the project's performance is based upon an integrative process with the input of design team members.

# Direct Solar

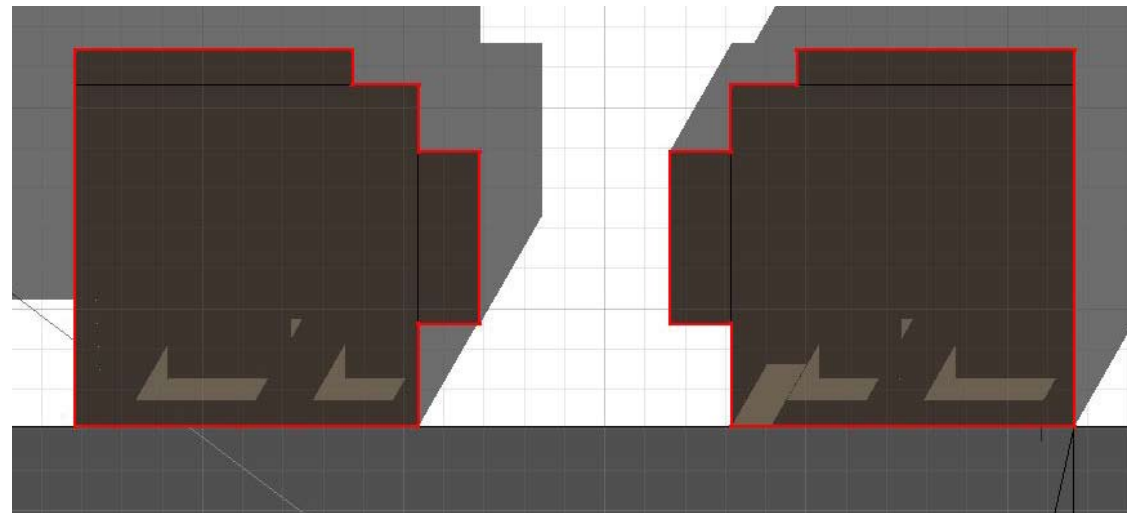


Mar 21st 12pm

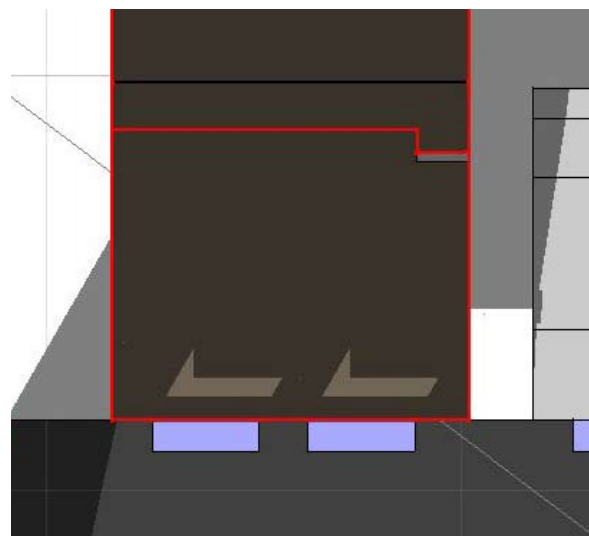
The project's orientation presents some situations that need responded to in a specific manner. The southern elevation of the classroom wing is orientated southeast. As shown in the image above, the exterior shading devices in their current size do not provide 100% shading for the classrooms.

It is recommended that the exterior shading device extend at least 1'-6" beyond the western edge of the window. Because of the orientation, the shade does not need to extend beyond the window edge on the eastern side. This is due to low sun angles.

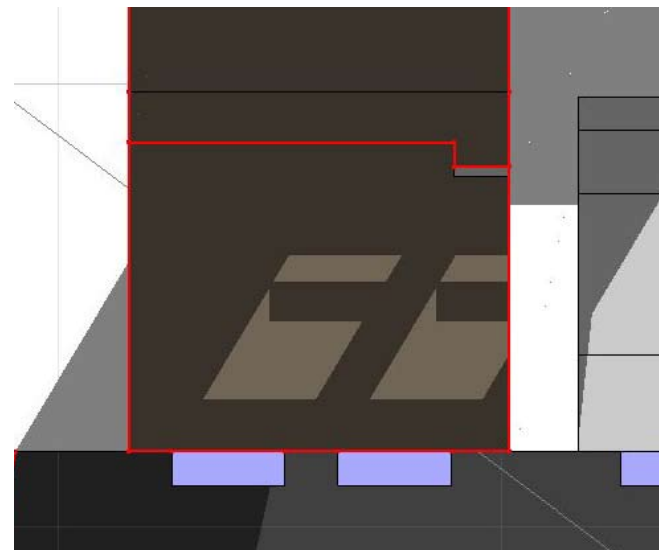




First Floor Classrooms March 21st 12pm



Second Floor Classrooms March 21st 12pm

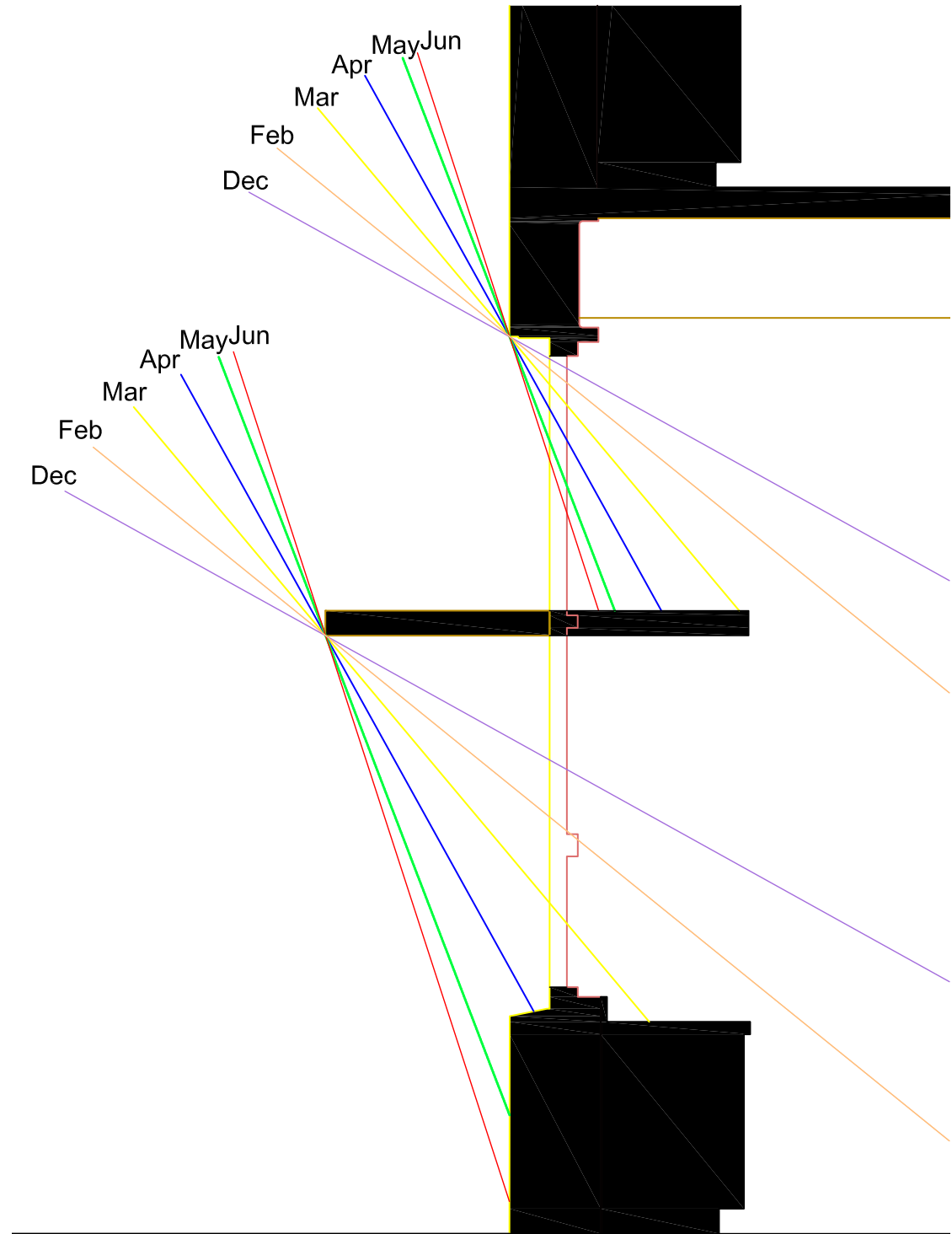


Second Floor Classrooms Feb 21st 12pm

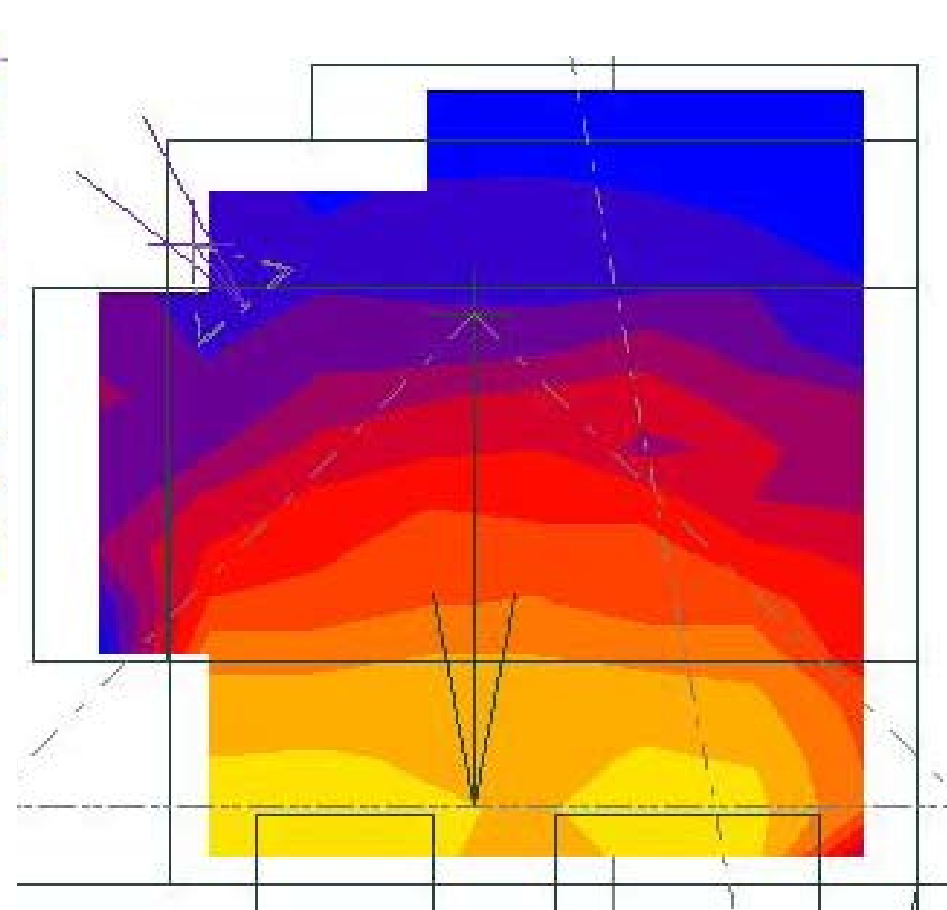
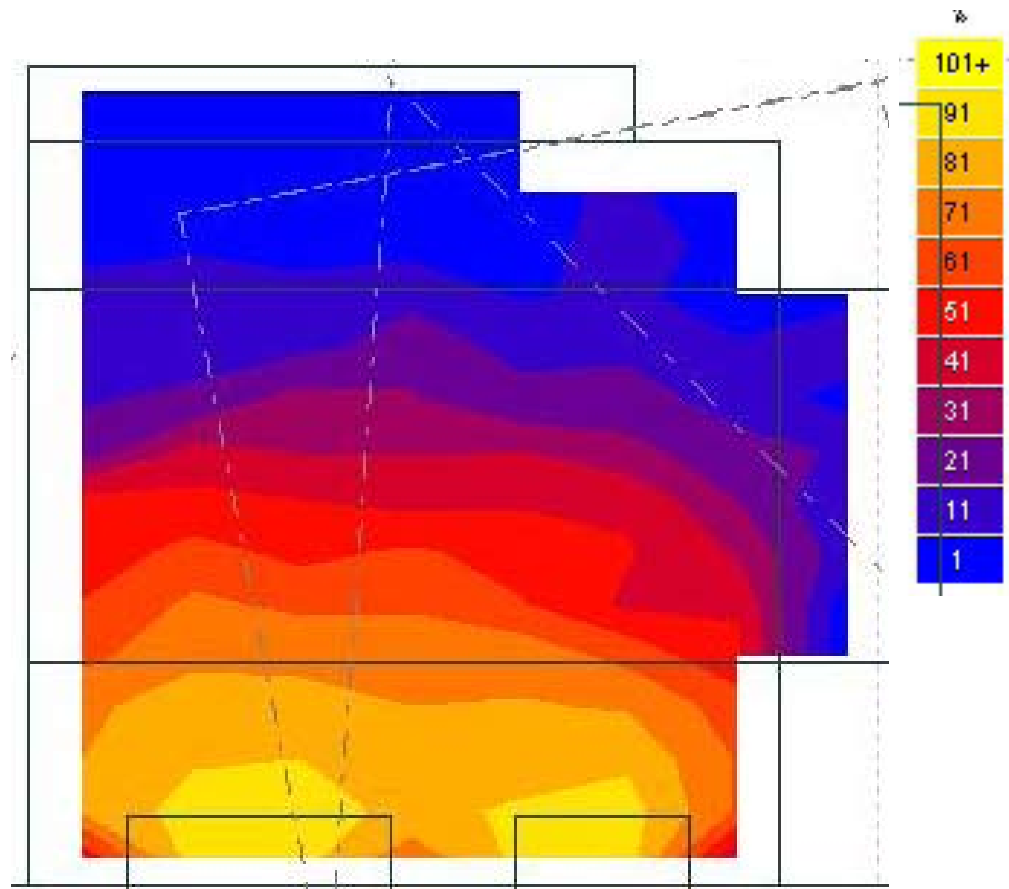
As shown in the images above, the exterior shading device needs to extend beyond the western edge of the window. Direct solar will be an issue from 8am till 10am from March to June and August to October.

In the winter months, November to February, direct solar will be an issue from 8:30am till 2pm under clear sky conditions.

Blinds will be needed in both the view and daylight windows to control the direct solar issues that will occur during clear sky conditions in the winter months.



# 1st Floor South Facing Classrooms



The first floor south facing classrooms were modeled with the following parameters.

**Internal Reflectances;** Floors 40%, Walls 70%, Ceiling 80%, Light Shelf 70%.

**External Reflectances;** Ground 26%, Exterior Shade 70% w/30% transparency.

**Glazing;** View window 60%, Daylight window 70%.

**Min. Target Illuminance;** 35fc

The classroom on the right was modeled with a door and the one on the left was not as a comparison. As shown in the DAR images, the targeted DAR is being met for at least 50% of the space. The bottom images are at 12pm on March 21 under overcast sky conditions, which is the worst case scenario. Those snap shot images help validate that only 50% of these spaces are meeting the target levels.

### Recommendations:

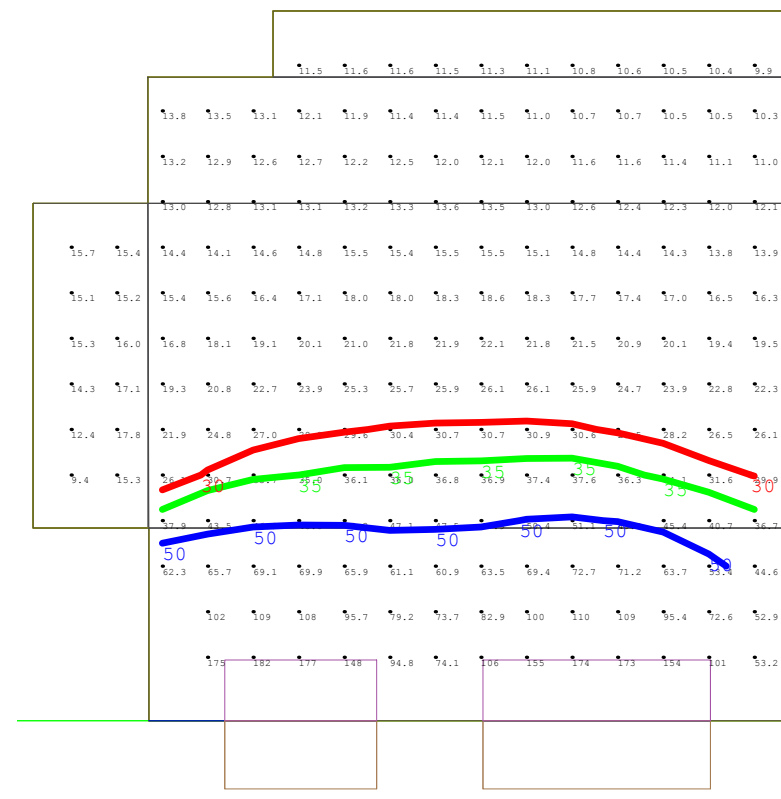
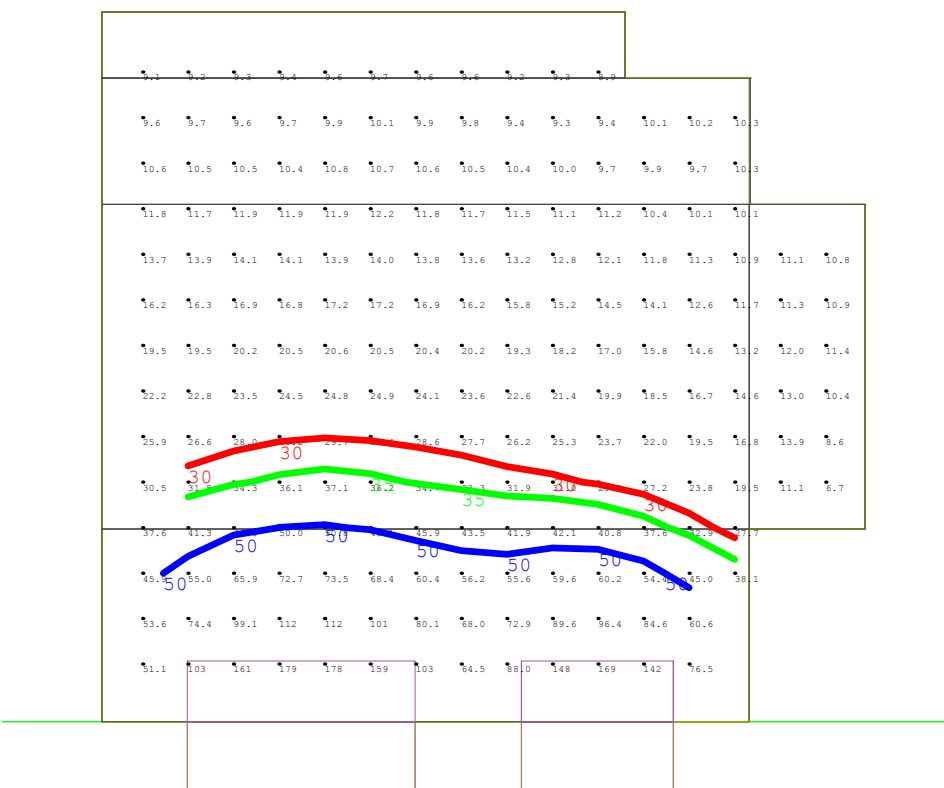
The optimal scenario is to have a view window of 60% with a SHGC around .3 and a daylight window of 70%. If for budget reasons, the glazing must be the same for each window, it is suggested that a VLT of 70%, +/- 2%, with a SHGC of around .35. A higher VLT will not hurt since the window is being shaded.

The exterior shading devices should be no less then 3'-0". The only means by which this could happen is if it is angled. Further simulations would be needed to validate performance. The shading device should have an openness value of 30-35%, see sample page at back of report.

The interior light shelf needs to be no more then 2'-8" in length from the glazing. The thinner the shelf the better, Any shelf greater then 2" in thickness should have an angled bottom surface.

Electrical lighting should be installed to compliment the daylighting. Based upon the analysis , the lighting should be parallel to the window wall. The first row should be on a sensor, the second and third rows should be at least dimmable or stepped switched.

Interior shades such as Meco should be used on both the daylight and view windows. Shades should be installed to work from the bottom up in the view window.



# 1st Floor North Facing Classrooms

The first floor north facing classrooms were modeled with the following parameters.

**Internal Reflectances;** Floors 40%, Walls 70%, Ceiling 80%, Light Shelf 70%.

**External Reflectances;** Ground 26%,

**Glazing;** 70% VLT

**Min. Target Illuminance;** 35fc

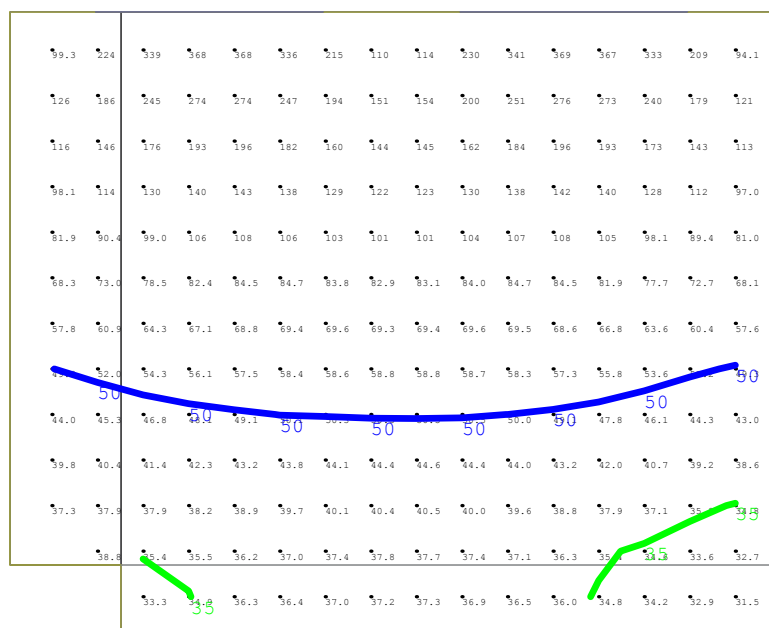
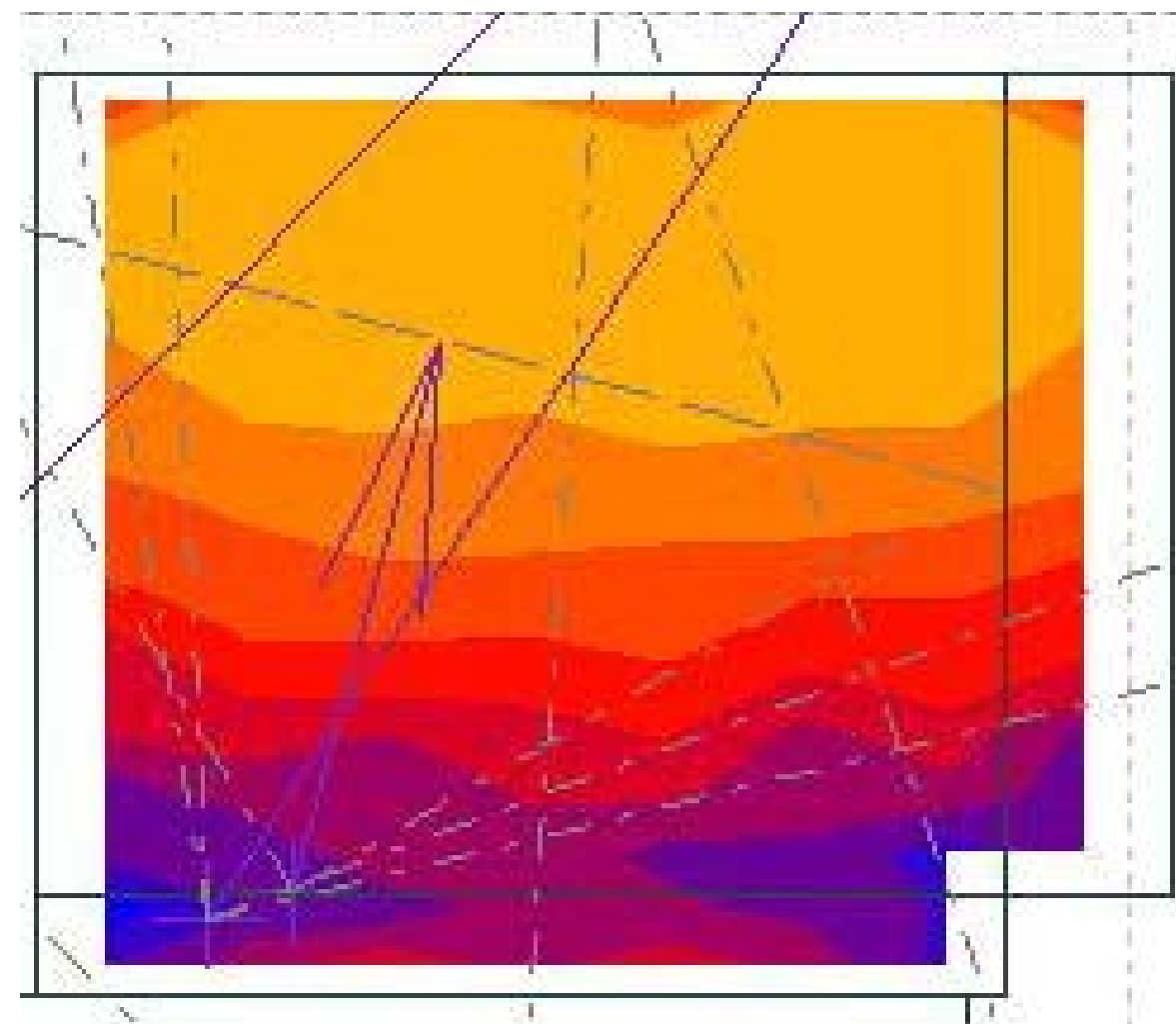
The targeted DAR is being met for almost 75% of the space. The smaller luxor image from March 21 under overcast sky conditions validates the illuminance levels.

**Recommendations;**

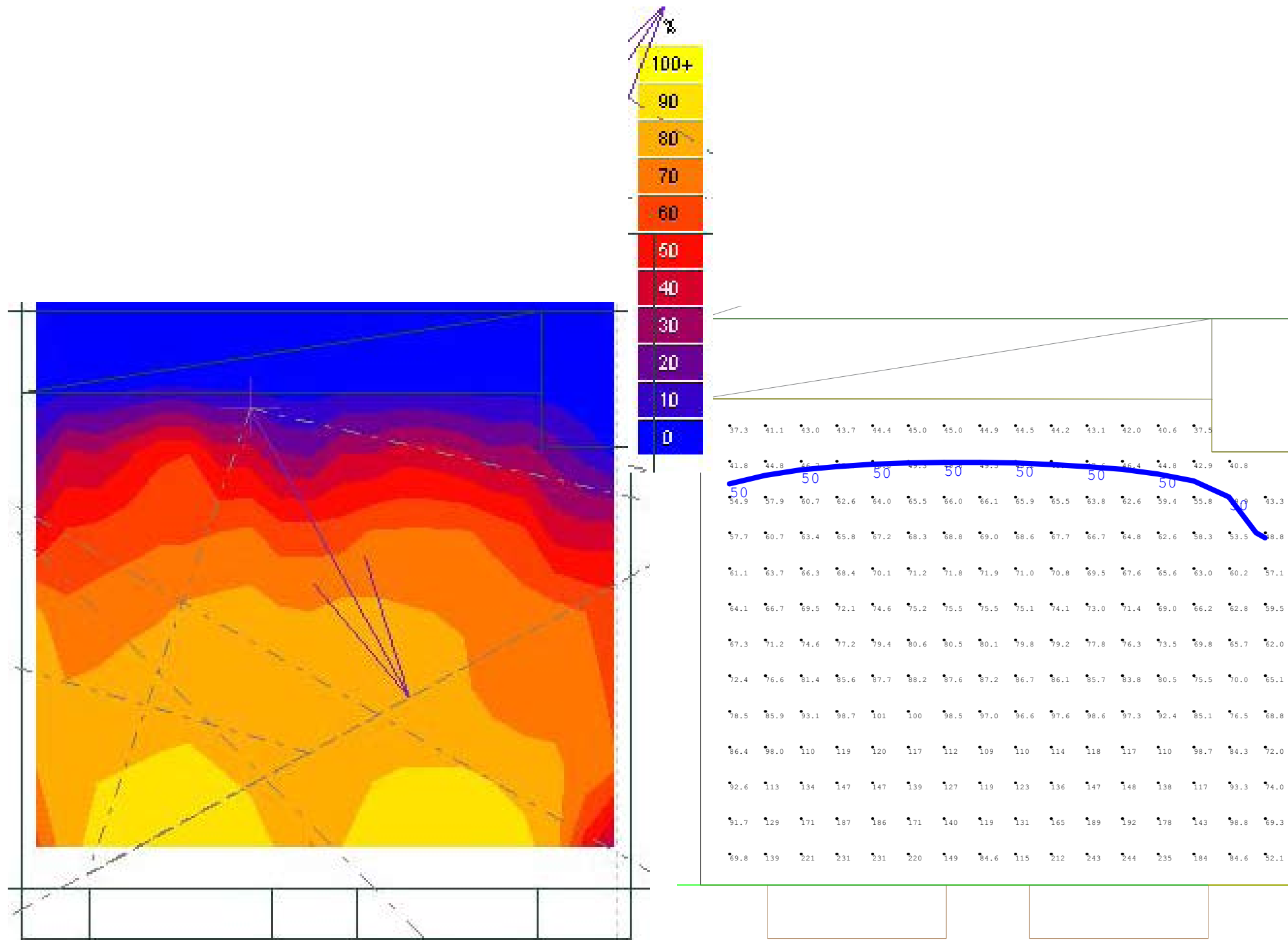
The window to floor area could increase slightly; it is currently at 11% and could go as high as 15%. A VLT of at least 70% should be used and the SHGC should be no more than .45.

The electrical lighting should be run parallel to the window wall and each row should be stepped switched.

Shades will be necessary due to some probable glare issues.



## 2nd Floor South Facing Classrooms



The second floor south facing classrooms were modeled with the following parameters.

**Internal Reflectances;** Floors 40%, Walls 70%, Ceiling 80%, Light Shelf 70%.

**External Reflectances;** Ground 26%, Exterior Shade 70% w/30% transparency, Roof 65%.

**Glazing;** View window 60%, Daylight window 70%. Clerestory 70%

**Min. Target Illuminance;** 35fc

The largest portion of the space is meeting the target DAR. This due to the bilateral daylighting condition.

### Recommendations:

The optimal scenario is to have a view window of 60% with a SHGC around .3 and a daylight window of 70%. If for budget reasons, the glazing must be the same for each window, it is suggested that a VLT of 70%, +/- 2%, with a SHGC of around .35. A higher VLT will not hurt since the window is being shaded.

The exterior shading devices should be no less than 3'-0". The only means by which this could happen is if it is angled. Further simulations would be needed to validate performance. The shading device should have an openness value of 30-35%, see sample page at back of report.

Electrical lighting should be installed to compliment the daylighting. Based upon the analysis and a bilateral daylighting condition it would be feasible to have the first two rows dimmable with a daylight sensor and the third row be stepped switched.

Interior shades such as Mecos should be used and installed to work from the top down.

## 2nd Floor North Facing Classrooms

The second floor north facing classrooms were modeled with the following parameters.

**Internal Reflectances;** Floors 40%, Walls 70%, Ceiling 80%, Light Shelf 70%.

**External Reflectances;** Ground 26%, Roof 65%.

**Glazing;** View window 60%, Daylight window 70%. Clerestory 70%

**Min. Target Illuminance;** 35fc

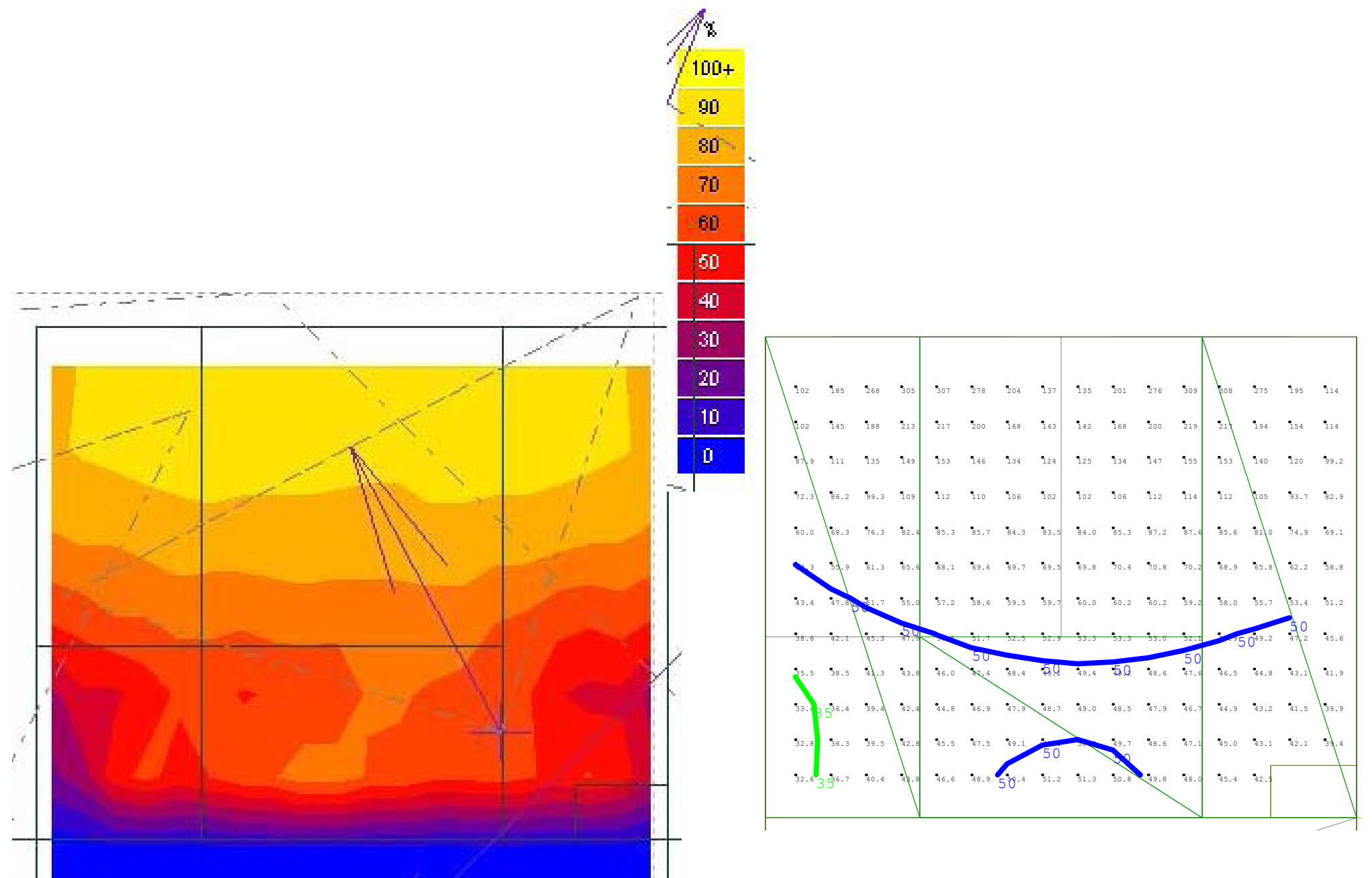
The largest portion of the space is meeting the target DAR. This is due to the bilateral daylighting condition. However, the distribution of light is not as even as it should be due to the clerestory covering only half of the space. Some light loss may also be occurring through the transom window into the hallway.

### Recommendations:

The clerestory should span the entire width of the space to create a more even distribution of light. There may be some contrast issues because of this.

It is suggested that the transom window to provide light to the hallway be removed. This will bounce more light into a regularly occupied space.

Electrical lighting should be installed to compliment the daylighting. Based upon the analysis and a bilateral daylighting condition it would be feasible to have the first two rows dimmable with a daylight sensor and the third row be stepped switched.





## 2nd Floor North Hallway

The second floor hallway was modeled with the following parameters.

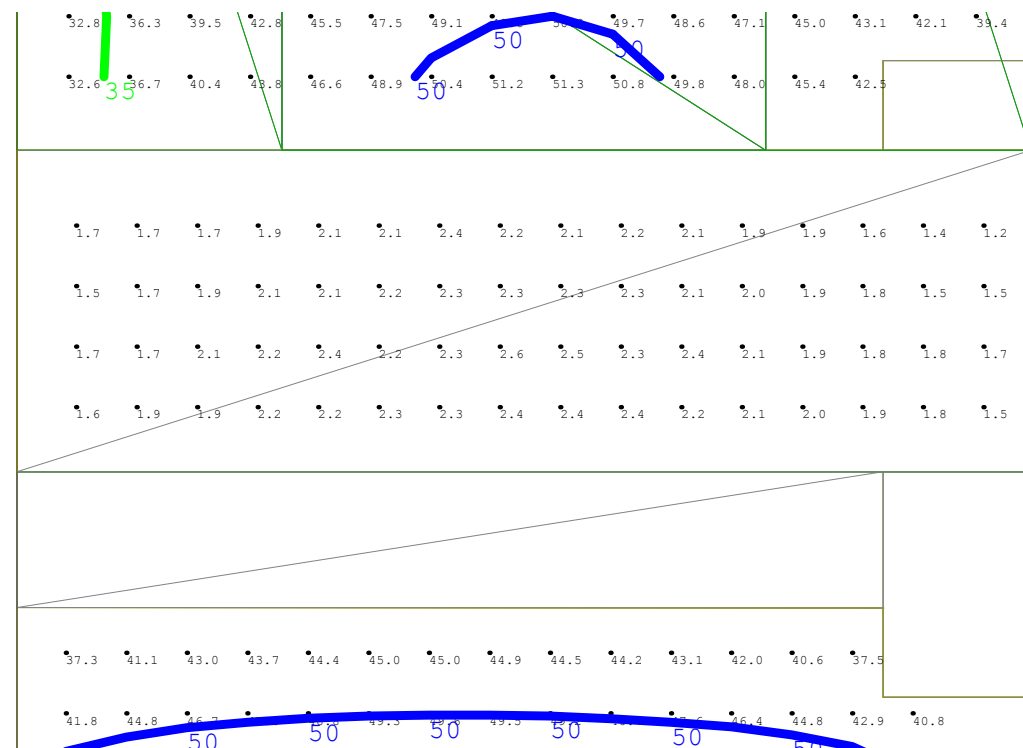
**Internal Reflectances;** Floors 40%, Walls 70%, Ceiling 80%, Light Shelf 70%.

**External Reflectances;** Ground 26%, Exterior Shade 70% w/30% transparency.

**Glazing;** 89%

**Min. Target Illuminance;** 5fc

Due to the height of the space and the amount of glass that the light must pass through before it reaches many of the viewable surfaces of the space, it is recommended that the transom window be removed.



The gymnasium modeled with the following parameters.

**Internal Reflectances;** Floors 40%, Walls 70%, Ceiling 80%.  
**External Reflectances;** Ground 26%, Roof 65%, Conc 33%  
**Glazing;** West Glazing 50%, Clerestory 35%, Interior 89%  
**Min. Target Illuminance;** 35fc

Three scenarios were run to look at three possibilities in effectively daylighting the gymnasium. Scenario 1 is the base design, Scenario 2 has a flat roof with the east clerestory located in the gym, Scenario 3 is the same as 2 except the roof is a butterfly roof.

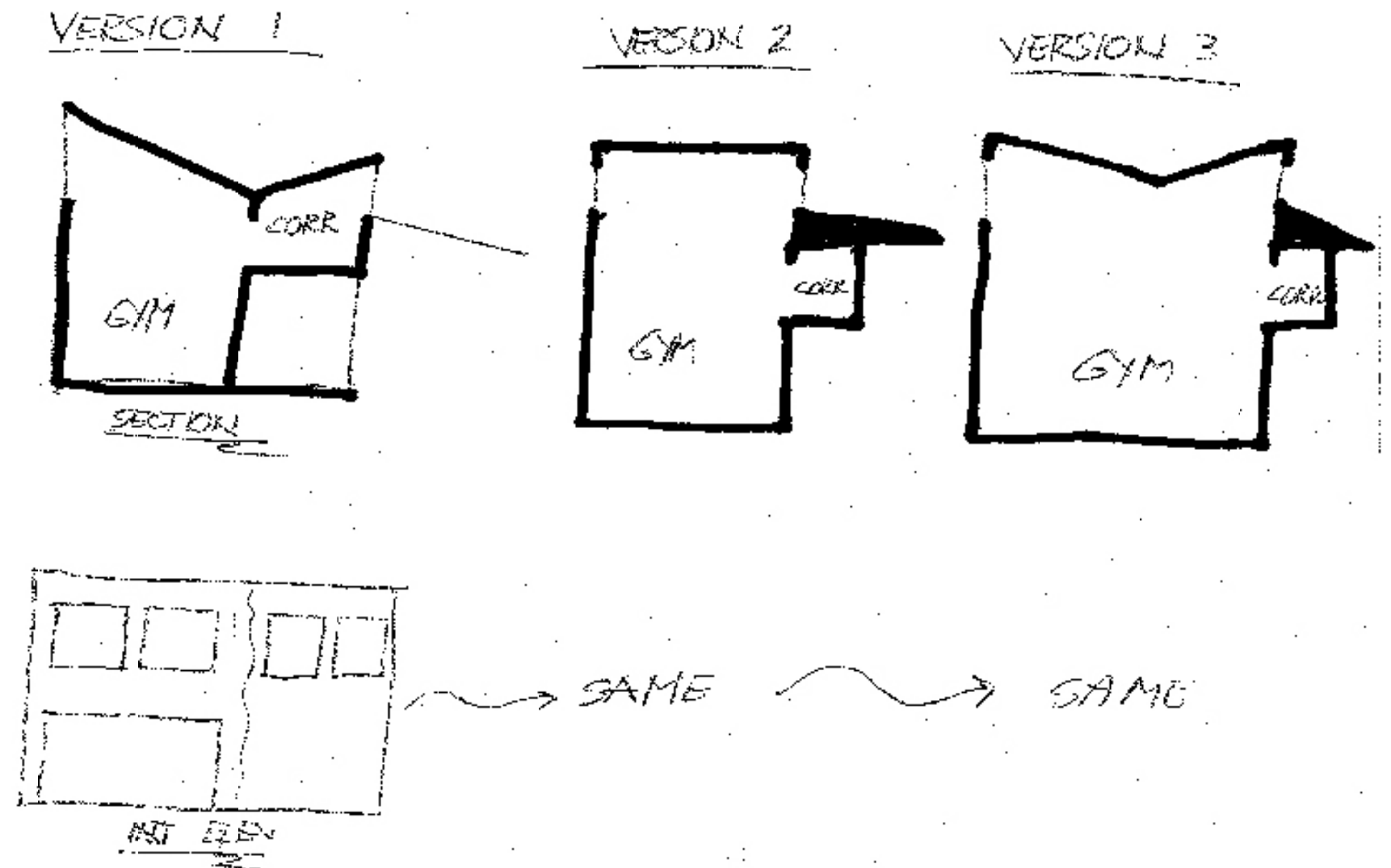
The target DAR for the gymnasium is 80% with a minimum illuminance value of 35fc. The scenario that comes the closest to that goal and provides an even distribution of daylight in the space is Scenario 3.

The direct solar component of the gymnasium was also examined due to the orientation and the use of glazing along the window wall.

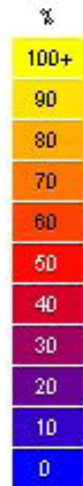
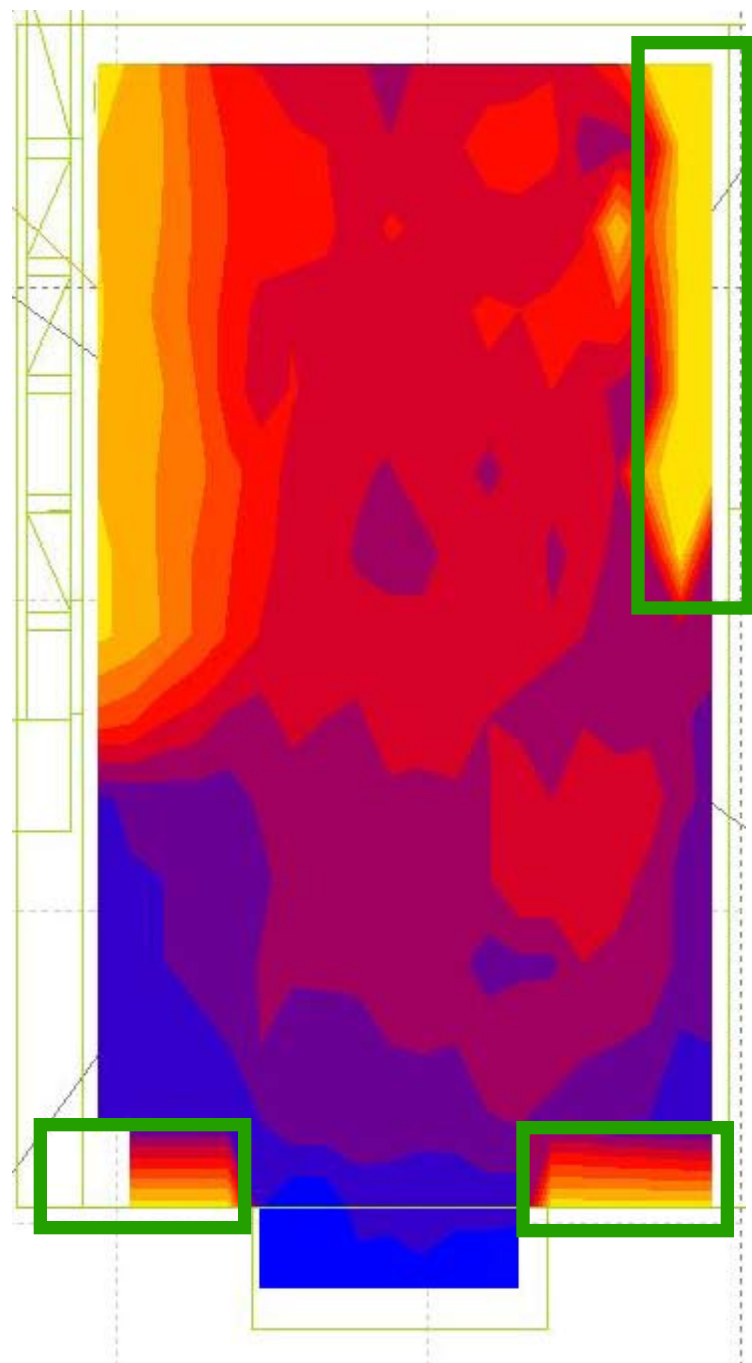
**Recommendations:**

To meet the daylighting goals and to provide the best quality of daylight into the space, it is recommended that scenario 3 is used.

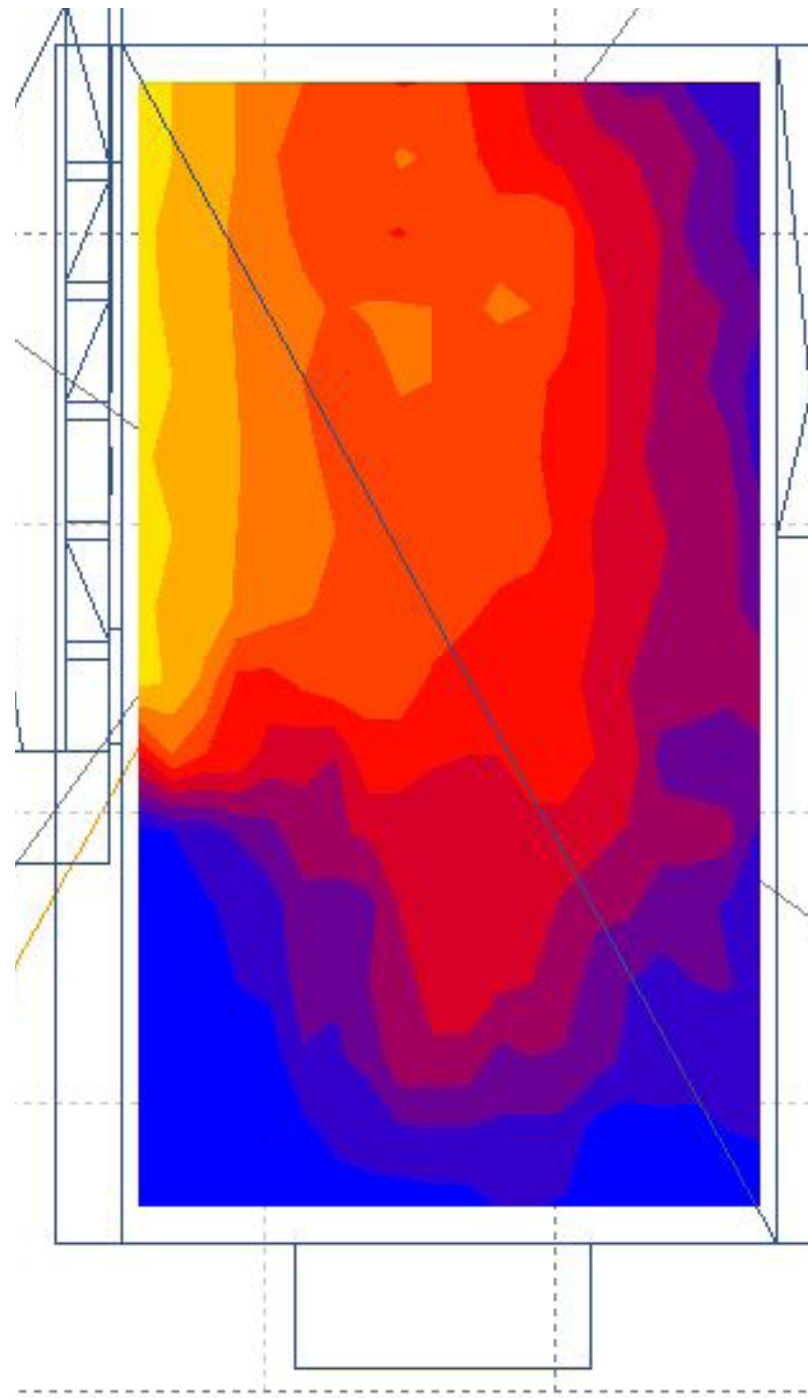
It has been noted that glazing at the floor along the west facade will remain. A glazing with a VLT of no more than 50% should be used. It is recommended that the amount of glazing be reduced and the entry roof be extended and or angled to help reduce the times of direct solar penetration.



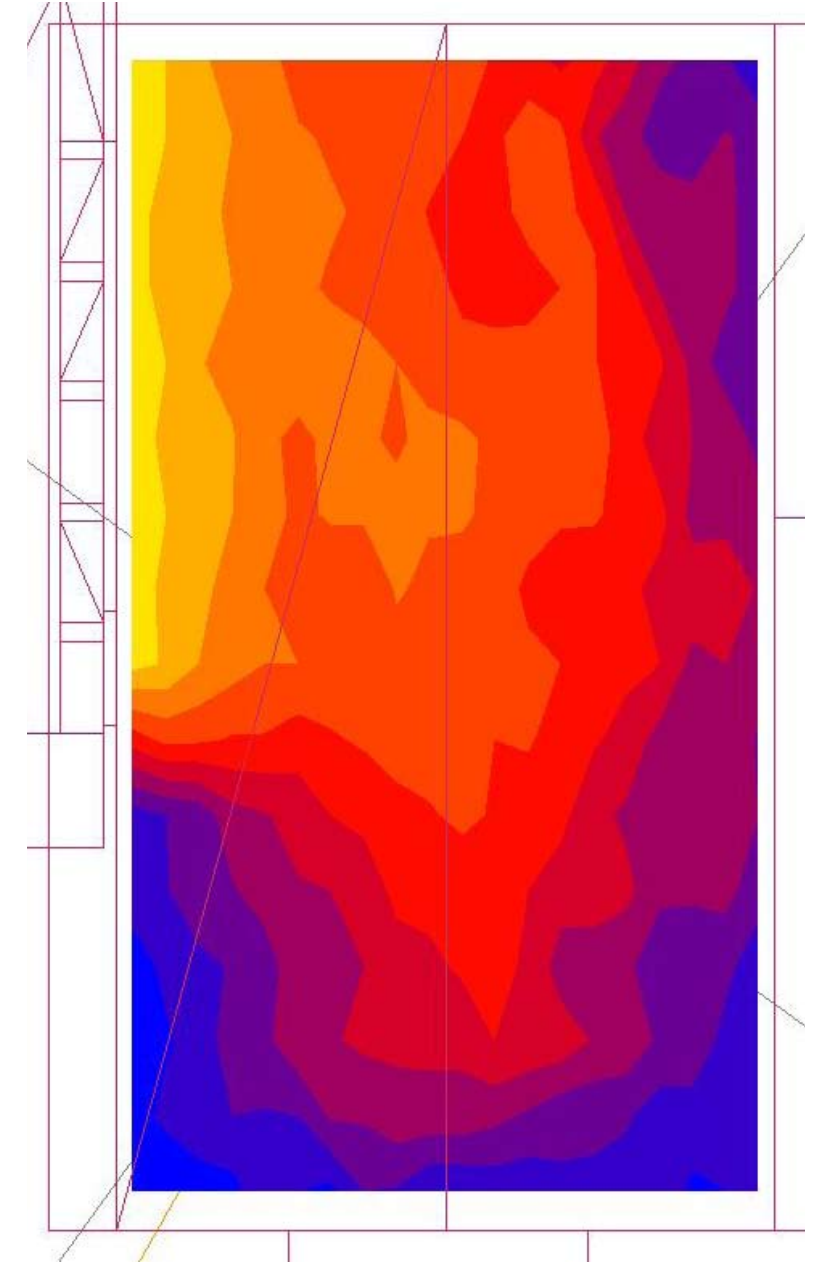
Scenario 1



Scenario 2



Scenario 3



Areas within the green box are modeling errors that occur due to model planes not being completely connected or sensors touching the planes.

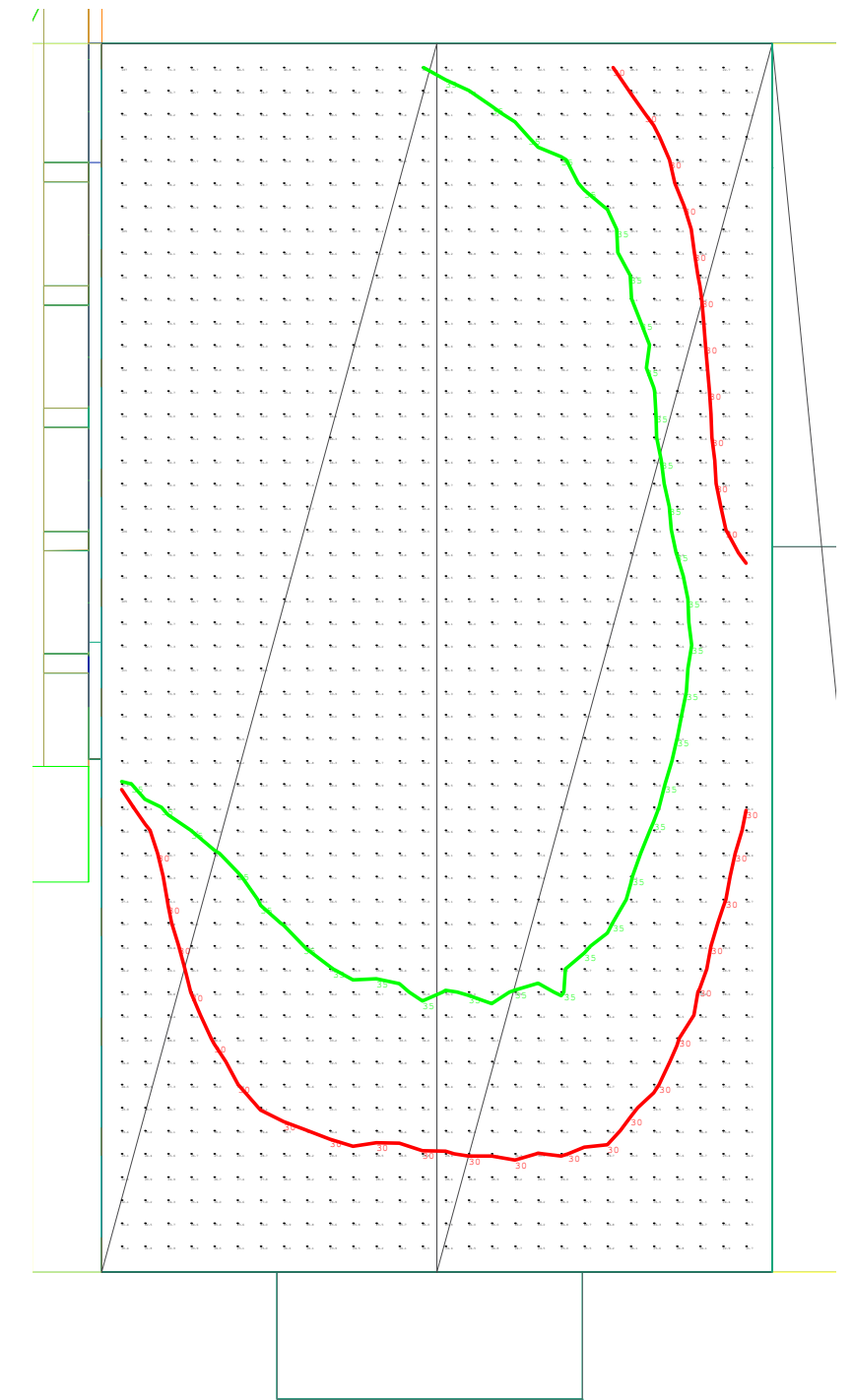
Scenario 1



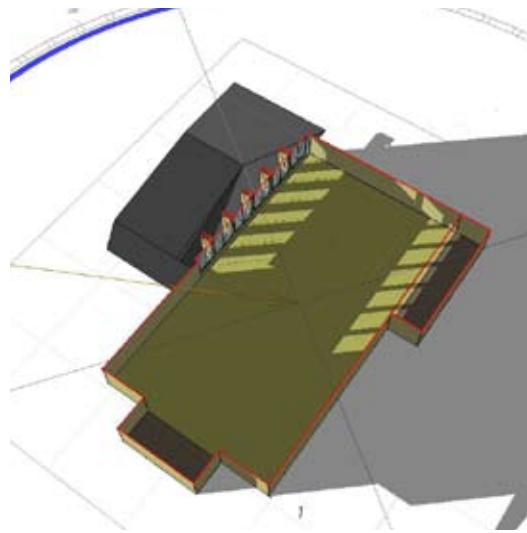
Scenario 2



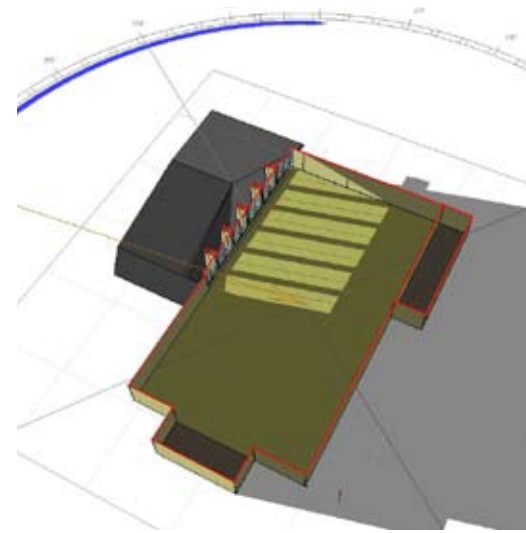
Scenario 3



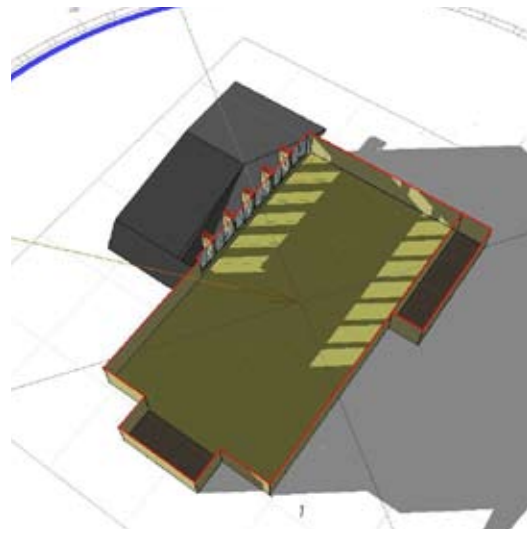




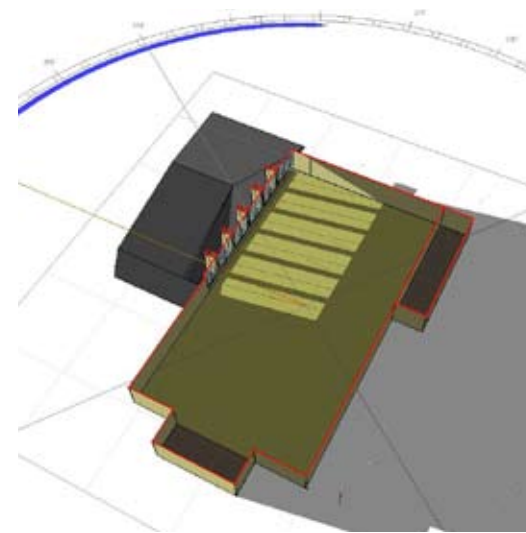
December 1pm



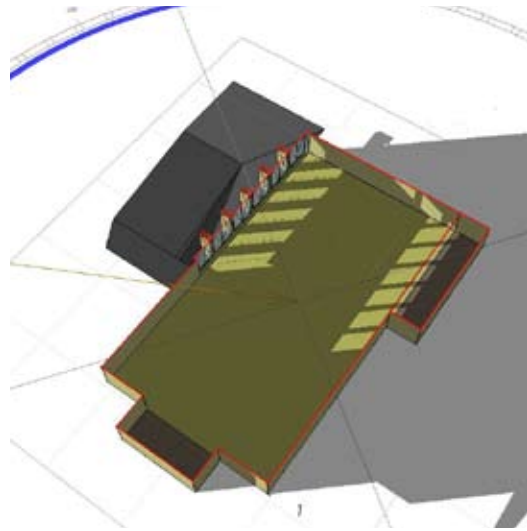
December 3pm



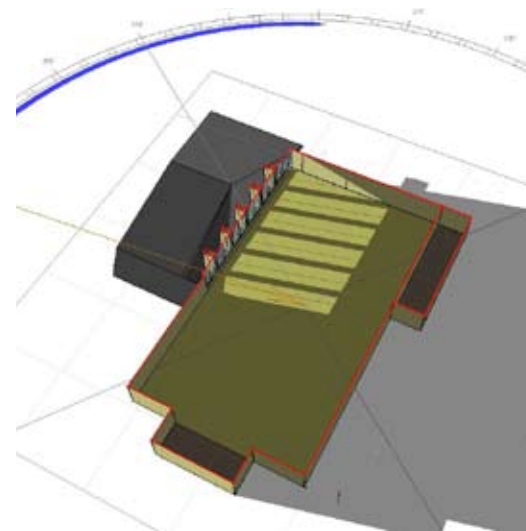
November 1pm



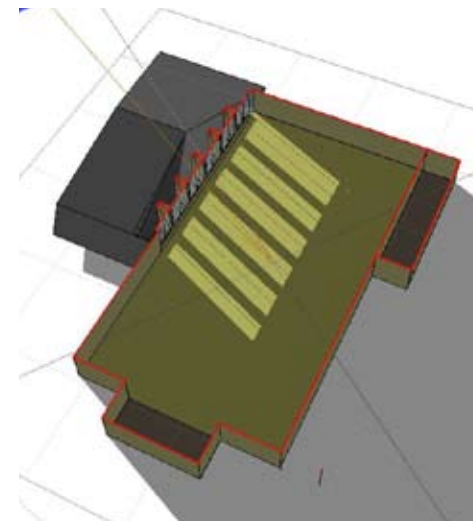
November 3pm



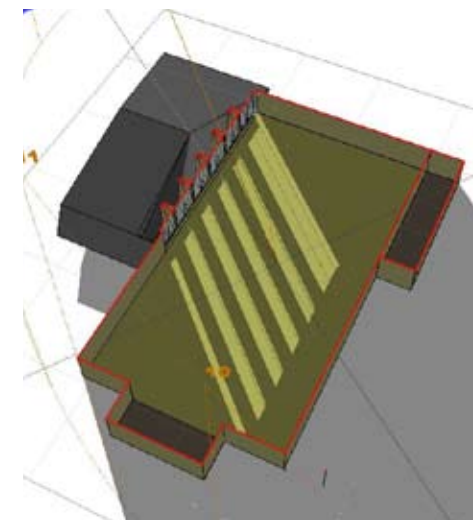
March 1pm



March 3pm



March 5pm



April 6pm

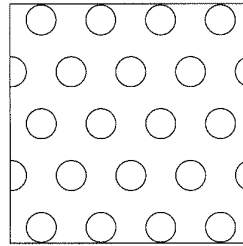
From the beginning of October till the end of March, there will be issues of direct solar penetration. In those months, this will occur during the school day. As the year moves on, from March until September, the effects will be greater later in the evening.

The main focus is to reduce this issue during the school day. If the overhang is extended 2'-0" and dropped 2'-0" in height, this will almost completely eliminate the occurrence of direct sunlight onto the playing surface. Another option is to angle the overhang, the exact angle and length has not been determined until this option is discussed with the design team.

The only really effective means to eliminate the direct sun from the entering the space in the late afternoon and early evening hours is to eliminate the glazing. This scenario will also produce glare in the space causing discomfort to the occupants. If this glazing is not removed, then is recommended that a glazing with no more than a 50% VLT be used. The use of a solar shade would reduce the effect of glare and direct solar issues in the space.

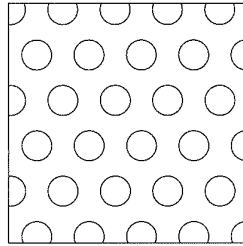
RS075 - RS083

RS075



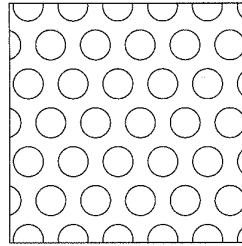
Hole Size: 1/4" Dia. x 1/2" Ctrs.  
Open Percentage: 23%

RS076



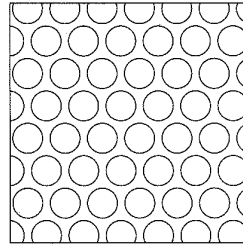
Hole Size: 1/4" Dia. x 7/16" Ctrs.  
Open Percentage: 30%

RS077



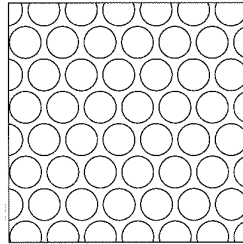
Hole Size: 1/4" Dia. x 3/8" Ctrs.  
Open Percentage: 40%

RS078



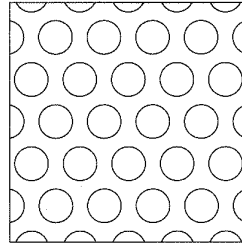
Hole Size: 1/4" Dia. x 5/16" Ctrs.  
Open Percentage: 58%

RS079



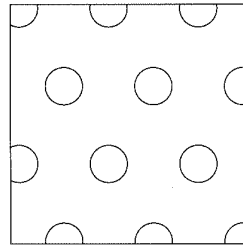
Hole Size: 17/64" Dia. x 5/16" Ctrs.  
Open Percentage: 66%

RS080



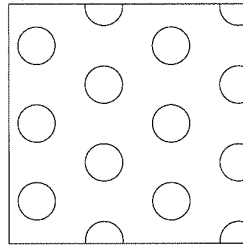
Hole Size: 9/32" Dia. x 13/32" Ctrs.  
Open Percentage: 43%

RS081



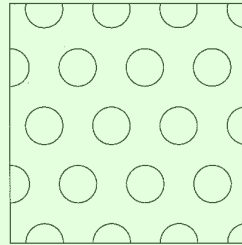
Hole Size: 5/16" Dia. x 3/4" Ctrs.  
Open Percentage: 18%

RS082



Hole Size: 5/16" Dia. x .650" Ctrs.  
Open Percentage: 21%

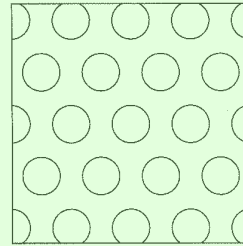
RS083



Hole Size: 5/16" Dia. x 9/16" Ctrs.  
Open Percentage: 28%

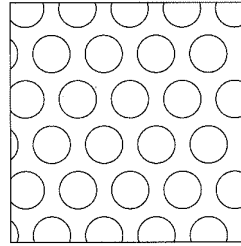
RS084 - RS092

RS084



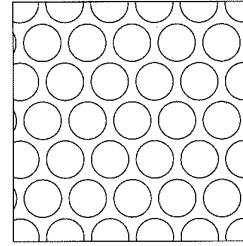
Hole Size: 5/16" Dia. x 1/2" Ctrs.  
Open Percentage: 35%

RS085



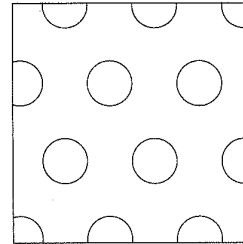
Hole Size: 5/16" Dia. x 7/16" Ctrs.  
Open Percentage: 46%

RS086



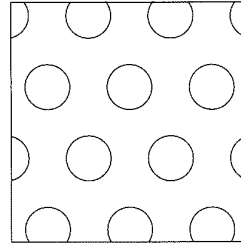
Hole Size: 5/16" Dia. x 3/8" Ctrs.  
Open Percentage: 63%

RS087



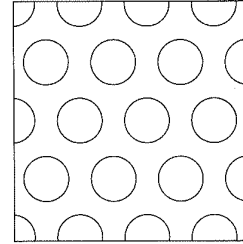
Hole Size: 3/8" Dia. x 3/4" Ctrs.  
Open Percentage: 23%

RS088



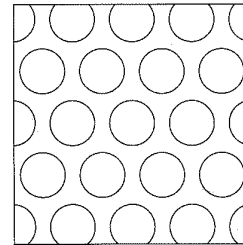
Hole Size: 3/8" Dia. x 11/16" Ctrs.  
Open Percentage: 27%

RS089



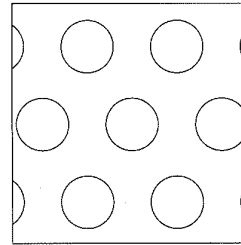
Hole Size: 3/8" Dia. x 9/16" Ctrs.  
Open Percentage: 40%

RS090



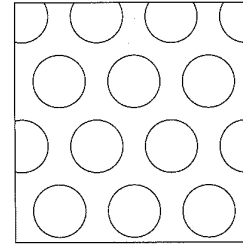
Hole Size: 3/8" Dia. x 1/2" Ctrs.  
Open Percentage: 51%

RS091



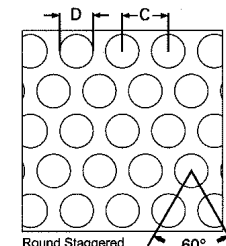
Hole Size: 7/16" Dia. x 3/4" Ctrs.  
Open Percentage: 31%

RS092

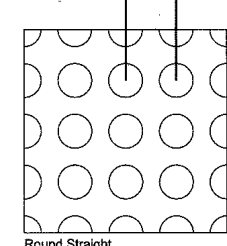


Hole Size: 7/16" Dia. x 5/8" Ctrs.  
Open Percentage: 44%

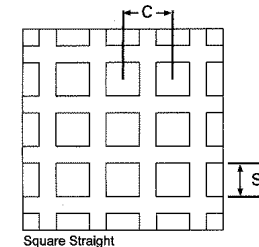
Open Percent



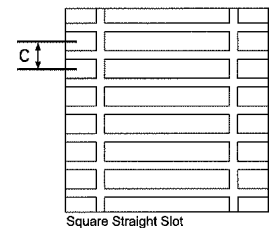
$$\frac{D^2 \times 90.69}{C^2} = \%$$



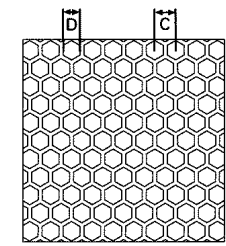
$$\frac{D^2 \times 78.54}{C^2} = \%$$



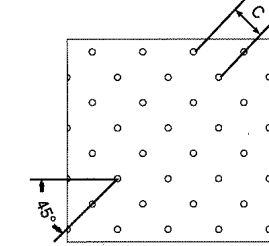
$$\frac{S^2}{C^2} = \%$$



$$\frac{L \times W}{C^2} \times 100 = \%$$



$$\frac{99.9 \times D^2}{C^2} = \%$$



$$\frac{157.08 D^2}{S^2} = \%$$

$$\text{H.P.S.I.} = \frac{\% \text{ Open Area}}{78.54 \times D^2}$$

Round Staggered

Please refer to our website at [www.accurateperforating.com](http://www.accurateperforating.com) to download detailed pattern drawings.

If you do not see the pattern you need, please contact us at 1.800.621.0273. We can easily create a custom tool for the job.

