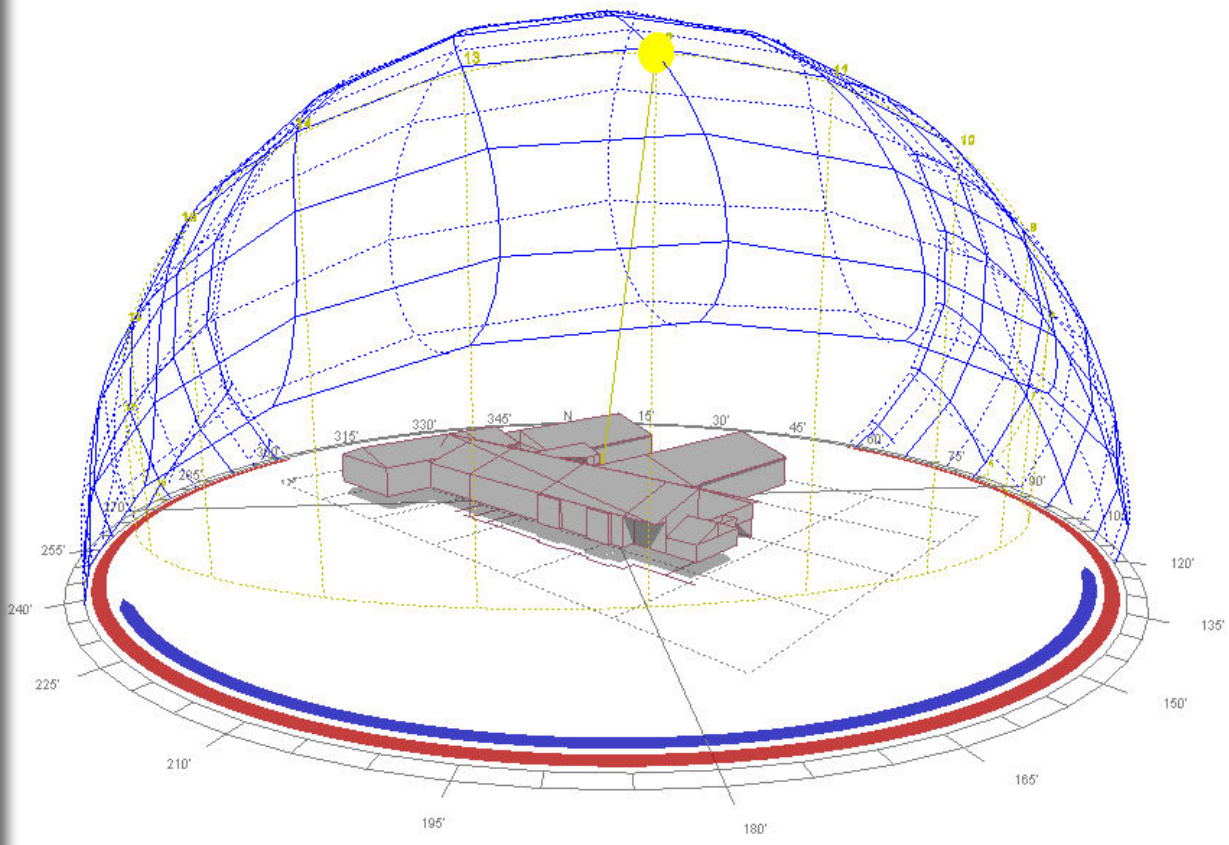
Rainbow Elementary School

COATESVILLE SCHOOL DISTRICT

PRELIMINARY DAYLIGHT ANALYSIS



Produced By:

7group

For:
Gilbert Architects
June 19, 2007

Table of Contents

USE DAYLIGHT, ITS FREE!!!!

Notes and Abbreviations

Note 1:

Green= df 1
Red= df2
Blue= df 3

Note 2:

All glazing analyzed with a VLT of 70%
Internal Reflectances: Ceiling 80%, Walls-70%, Floor-40%
Calculation points are on a 2'x 2' grid.

VLT-Visual Light Transmittance
SHGC-Solar Heat Gain Coefficient
df- Daylight Factor
fc- Footcandle

Summary

This preliminary daylight analysis looks at the Rainbow Elementary School as designed to date. The primary areas that were analyzed are the direct solar aspect of the entire project and the current daylighitng conditions of the classrooms. A section is dedicated to recommendations to improve the daylighting scenarios of the project.

The direct solar analysis focuses primarily during the occupation time of the project throughout the year. The primary solar dates are the solstices and equinoxes and the effects of the low sun angles.

One section of one of the classroom wings is analyzed to determine current daylighting conditions. Overcast and clear sky conditions are analyzed for the equinoxes.

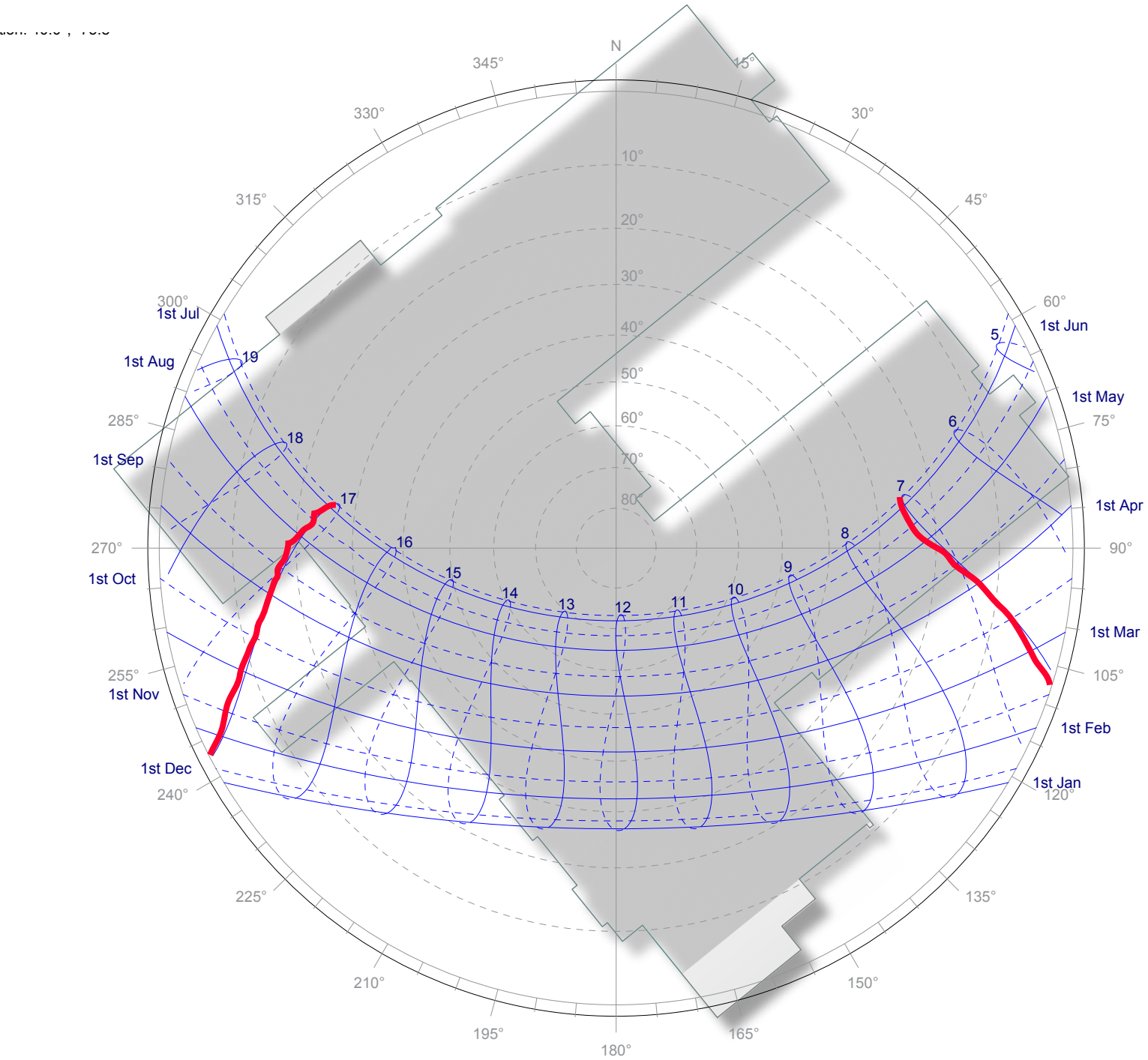
The recommendation section provides possible solutions to improve the daylighting scenarios of the entire project. These recommendations are based upon the analysis and the experience of the review team.

This is only a preliminary analysis, further analysis will be necessary if significant changes are made to the current design. This information should be provided to the design team, engineers and owners.

Direct Solar Analysis

Direct solar can cause problems for a building. Direct penetration into spaces causes unwanted glare and solar heat gain. The latitude of the project has the primary cooling conditions from late September to mid to late April. Reducing the amount of direct solar onto transparent surfaces will help in the reduction of heat loads. Solar heat gain in the heating months of the project are not much of an issue at this latitude being that this is not the primary occupation time.

The orientation of the project causes certain facades to receives direct solar year round. Consideration should be taken that certain facdes and window treatments are responsive to the solar aspects and natural environment and not just an aesthetic architectural gesture.



PEC SOLAR CALCULATOR — TOTAL RADIATION

Annual Version, PG&E Energy Center

Orientation Here
Project Title here

INPUT:

LATITUDE	40
SURFACE AZIMUTH (0=S,+E, -W)	180.0
SURFACE TILT (90 = Vert)	90
TRANS @ NORMAL	0.9

ENTER DESIRED VARIABLE: 8

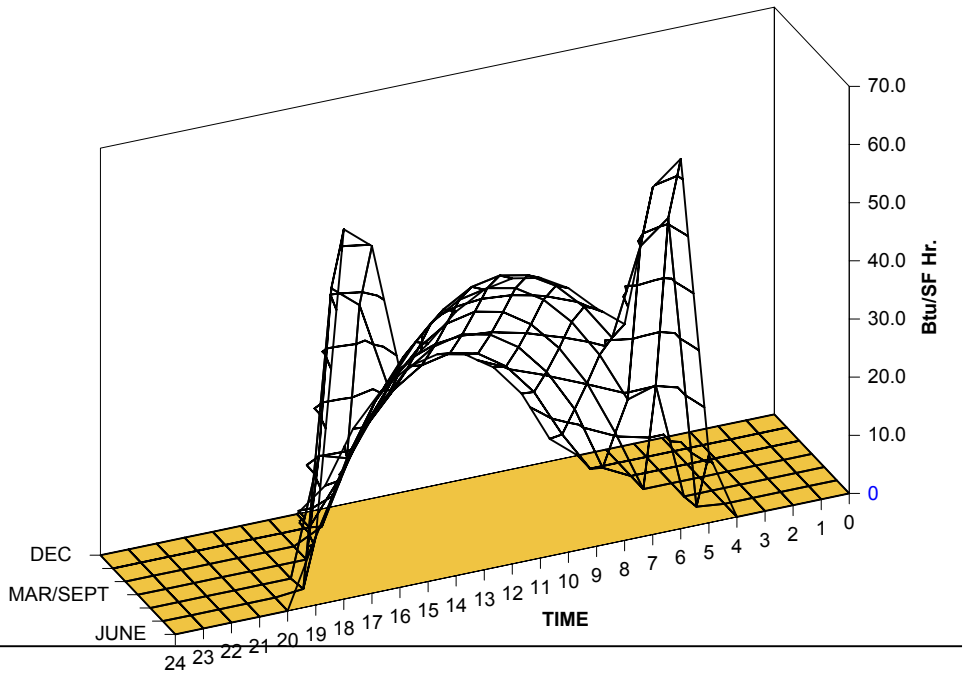
1 = Solar Altitude
2 = Solar Azimuth
3 = Solar Surface Azimuth
4 = Angle of Incidence
5 = Profile Angle
6 = Direct Radiation
7 = Diffuse Radiation
8 = Total Radiation
9 = Trans. Radiation

The above spreadsheet calculates the major solar variables for a specific latitude and surface orientation. For more information contact Charles C. Benton or Robert Marcial, The PG&E Energy Center, 851 Howard Street, San Francisco, CA 94103

ANNUAL SUMMARY: **Btu/SF Hr.**

Hour	DEC	JAN-NOV	FEB-OCT	MAR-SEP	APR-AUG	MAY-JUL	JUNE
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0.5	11.7
6	0	0	0	0	20.1	51.2	63.6
7	0	0	2.4	10.7	18.7	47.3	59.7
8	3.9	6.9	13.5	20.2	27.4	32.6	37.2
9	12.7	15.2	20.9	27.3	34.0	38.9	40.9
10	18.2	20.6	26.2	32.4	38.9	43.5	45.4
11	21.4	23.8	29.3	35.5	41.9	46.4	48.2
12	22.5	24.9	30.4	36.6	42.9	47.3	49.1
13	21.4	23.8	29.3	35.5	41.9	46.4	48.2
14	18.2	20.6	26.2	32.4	38.9	43.5	45.4
15	12.7	15.2	20.9	27.3	34.0	38.9	40.9
16	3.9	6.9	13.5	20.2	27.4	32.6	37.2
17	0	0	2.4	10.7	18.7	47.3	59.7
18	0	0	0	0	20.1	51.2	63.6
19	0	0	0	0	0	0.5	11.7
20	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0
TOTAL	135	158	215	289	405	568	663

TOTAL RADIATION



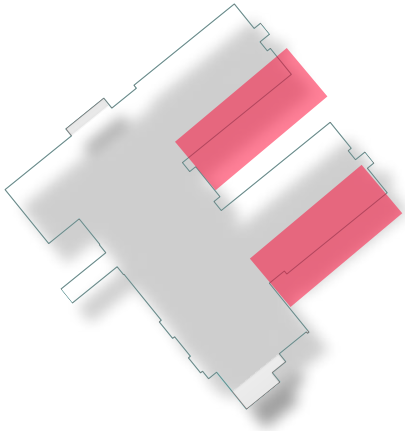
NOTES:

1. Use this calculator by inserting values in the input (red) section.

2. Radiation values are calculated using approximate algorithms to suggest patterns only. Verify carefully with other sources to confirm reliability.

DISCLAIMER:

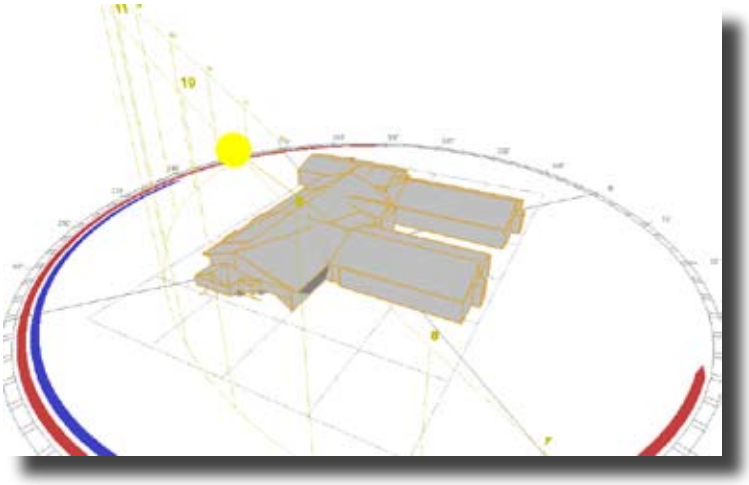
We use this worksheet as a preliminary, informal calculator for solar variables and make no claims of elegance or accuracy. For important calculations check these figures using a second and/or third source (e.g. Chap. 27, ASHRAE Handbook of Fundamentals.) PG&E disclaims all implied warranties, including without limitation warranties of performance and fitness for a particular purpose. This software is provided "as is" and the user assumes the entire risk as to its quality and performance.

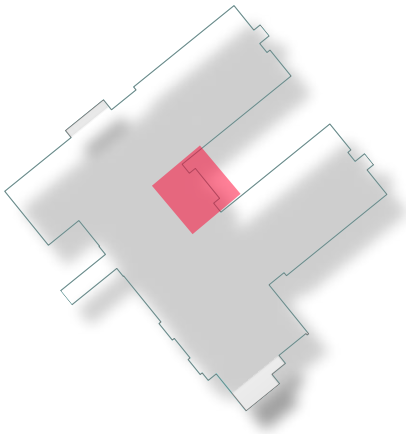


Southeast Facing Classrooms

Will receive direct sun from sunrise till 2pm daily and year round.

Recommendations; Shades will be needed. Exterior shading devices should be considered and possibly interior lightshelves. Glazing with a low SHGC will be needed.

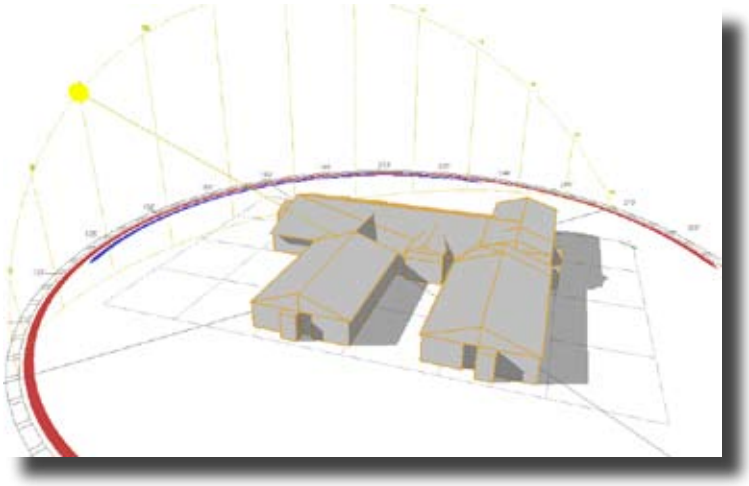


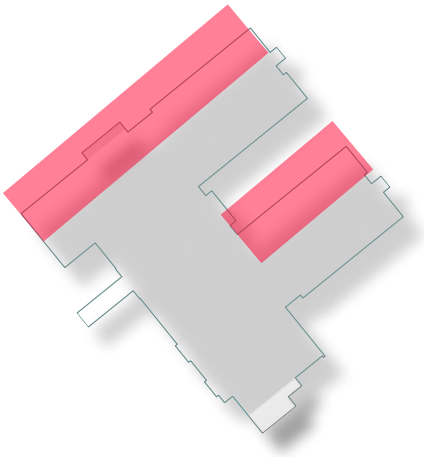


Upper Media Center

Some direct solar issues from August to late September and late March till April.

Recommendations: Shades, Glazing with a high VLT and low SHGC.

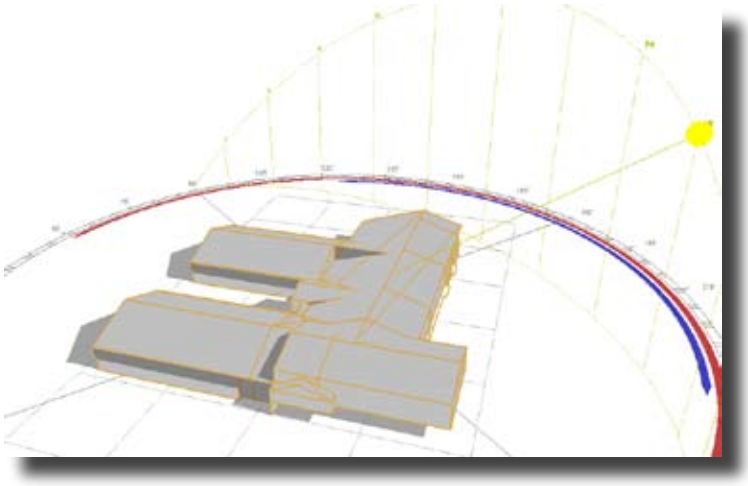


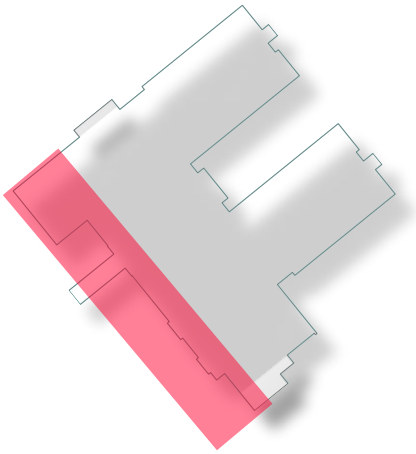


Northwest Facing Classrooms & Gymnasium

Direct solar from 2pm till sunset year round. Only the furthest facing facades will receive direct till sunset. Inner classroom facade will receive direct sunlight for about 3-4 hours.

Recommendations: Shades will be necessary and a decent SHGC glazing. The high windows in the gymnasium will cause for direct solar penetration onto the playing surfaces. If not attempting to effectively daylight the gym, Use low VLT glazing or a translucent material.

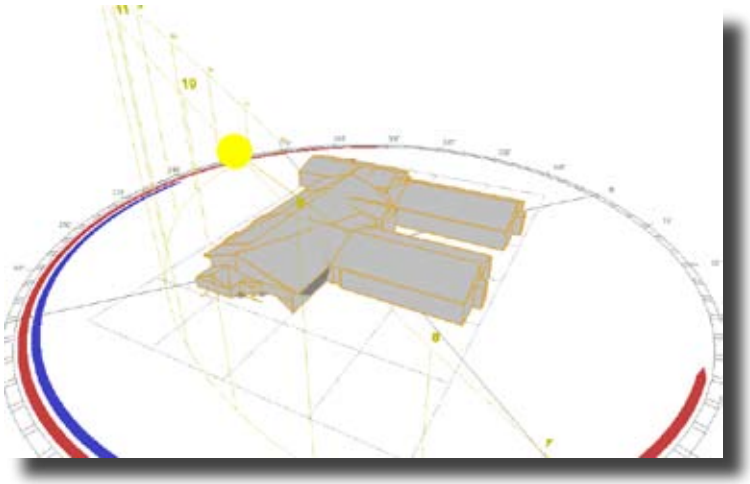




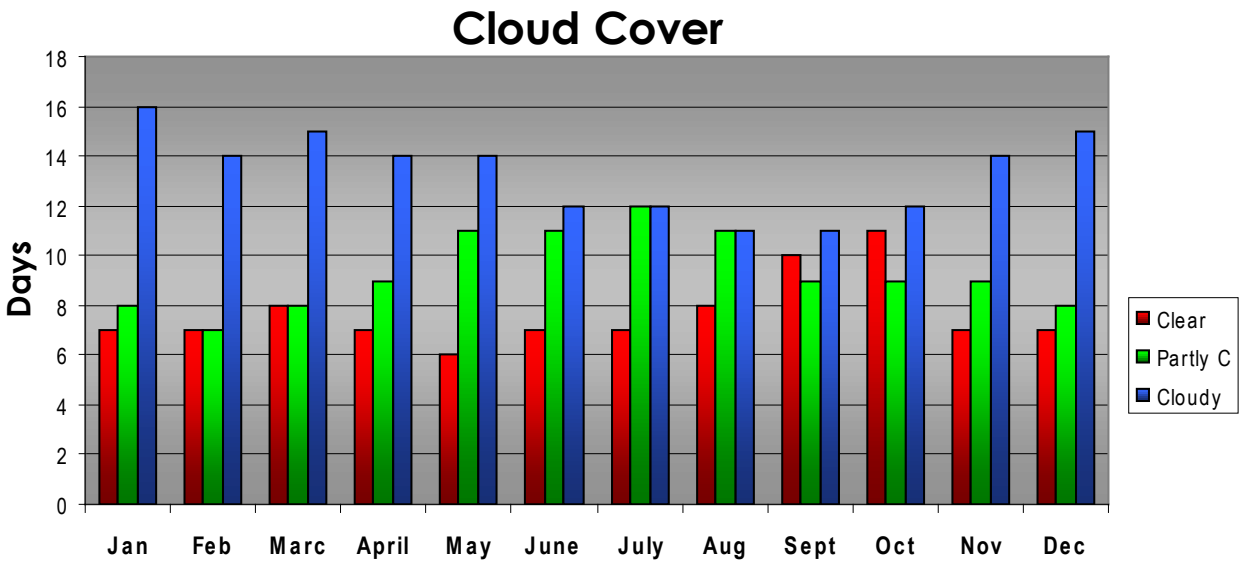
Southwest Facing Facade

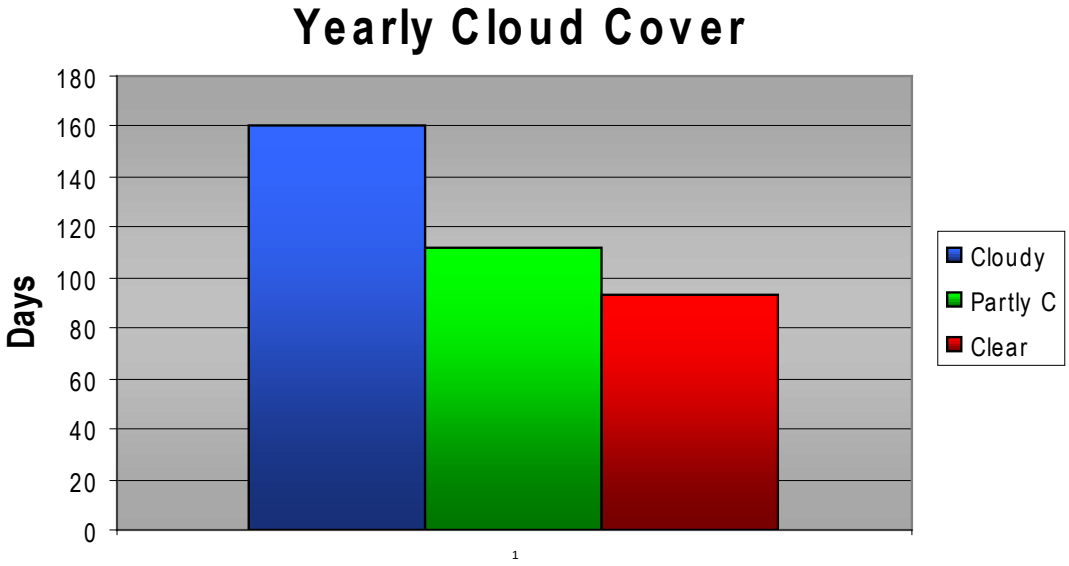
From 9:45am till sunset year round, this facade will receive direct solar.

Recommendations: The current design would only require shades in the office areas. High VLT and low SHGC glazing. Effective daylighting for the cafeteria would be through a top light scenario and would need analyzed.



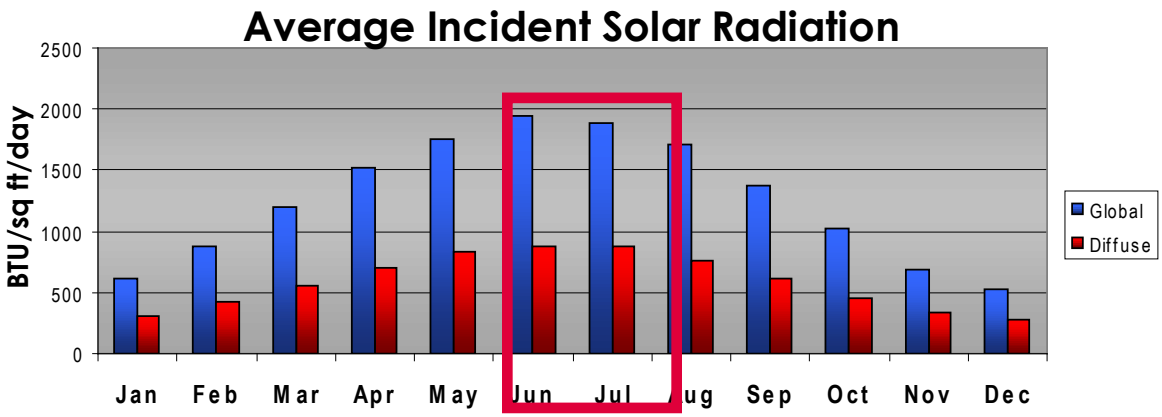
Sky Conditions



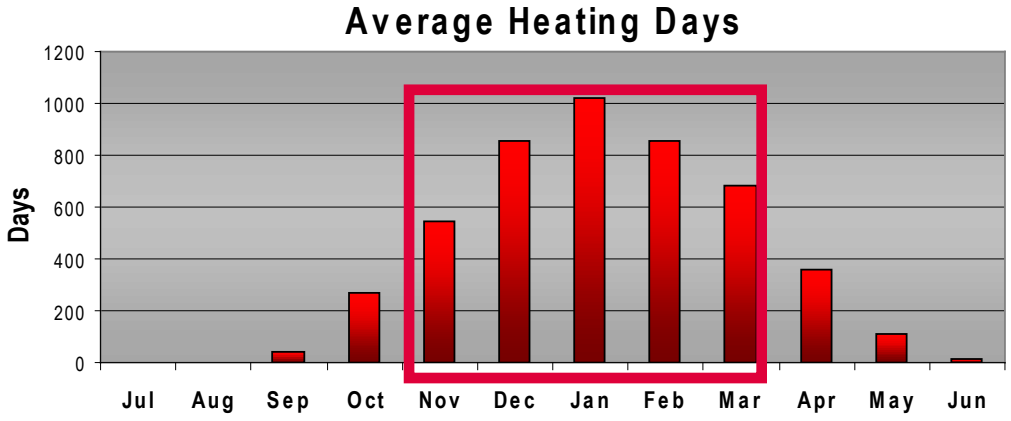


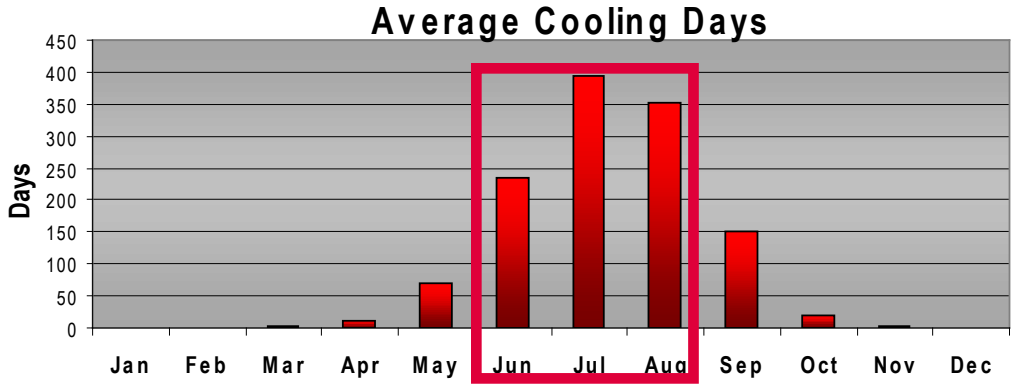
The sky condition data is for Philadelphia PA, There is on average of 93 clear days, 112 partly cloudy, and 160 cloudy days. Taking half of the partly cloudy and adding one half to each clear and cloudy days results in 216 cloudy and 146 clear days. This equals 32% more cloudy days than clear. This means that the daylighting scenarios for this project should be designed for overcast days. Also, the primary occupancy of the project is during the year when there is a higher percentage of overcast sky conditions.

Weather Conditions



The months with the highest radiation is during the non-occuppied time of the project. However some of the highest radiation is during the heating months of the year. This is a reason for reducing solar heat gain and using low SHGC glazing on overexposed facades.

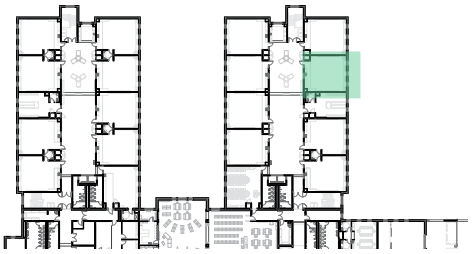




The data shows that there are more heating than cooling days and the cooling days are primarily during the non-occuppied time of the year. Solar heat gain in the winter months is not as much of an issue.

Classrooms

This analysis looks at both first and second floor classrooms facing southeast and northwest along with the work area in between the classrooms. These spaces were analyzed under clear and overcast sky conditions on March 21st.

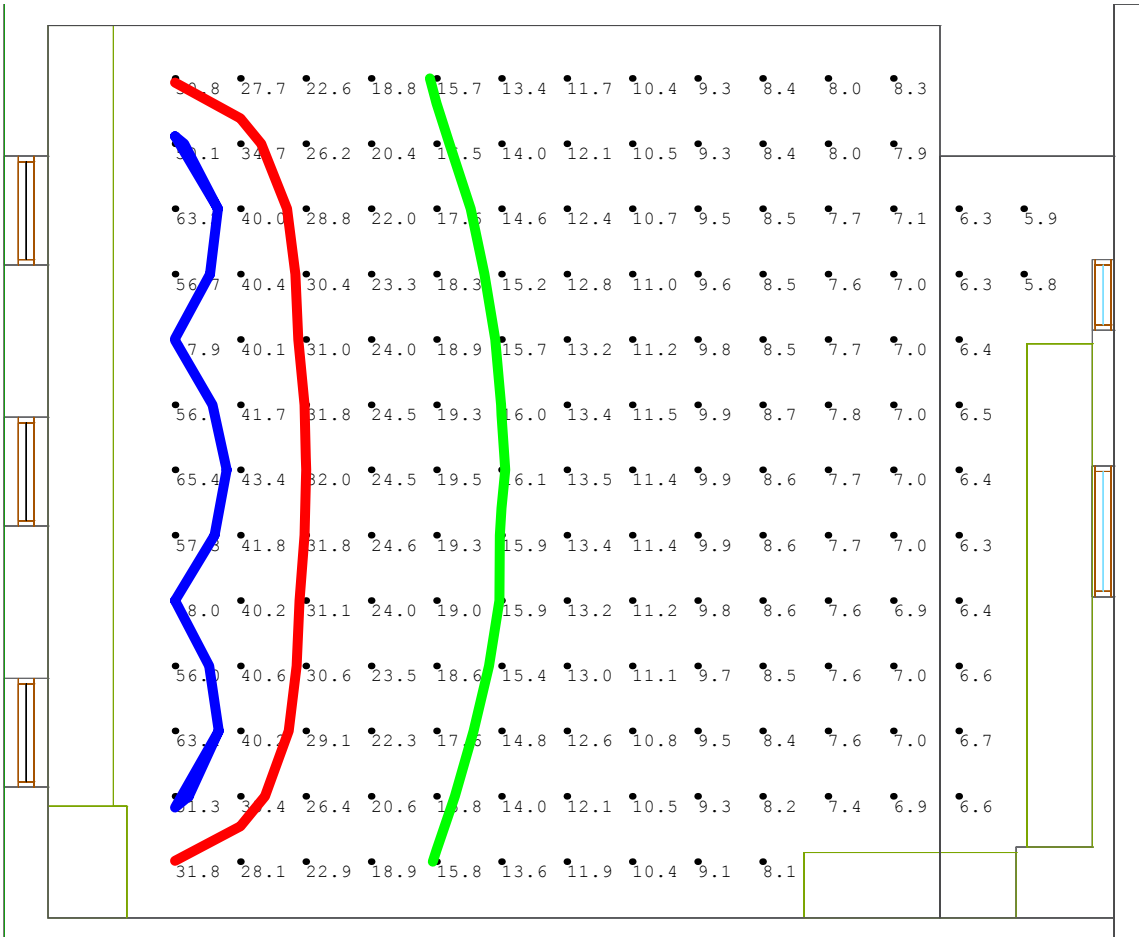


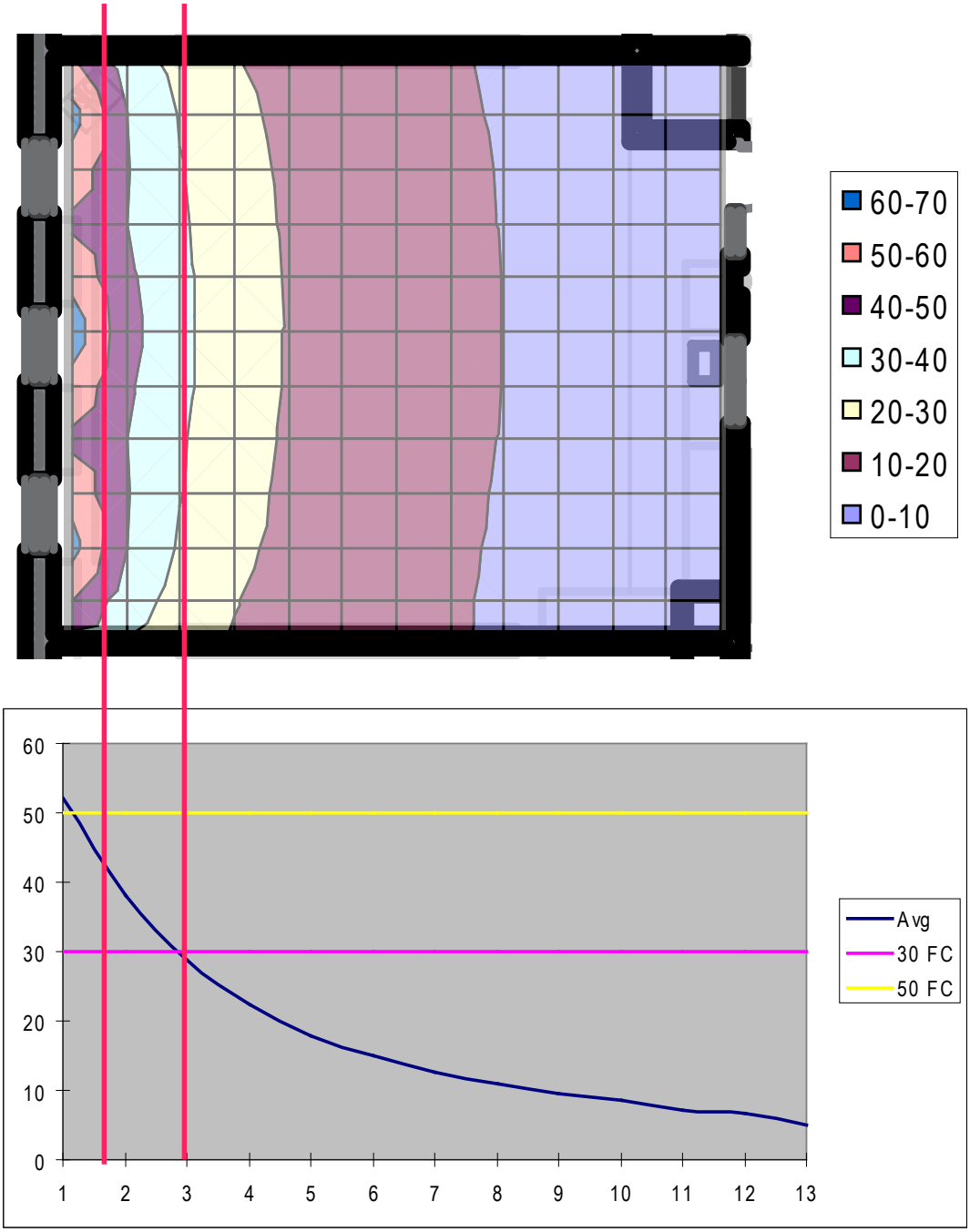
First Floor Southeast Facing

Overcast Sky Conditions

Window/Floor Ratio: 5%
Avg: 20 fc
Max: 88 fc
Min: 9 fc
Contrast Ratio: 1:10

See Notes





The first floor, southeast facing classrooms do not have a sufficient amount of daylight under overcast sky conditions. The graphs above show that there is a lot of glare. The steeper the curve equals more glare. The image on the previous page shows that there will be large amounts of contrast due to the low window to floor area ratio.

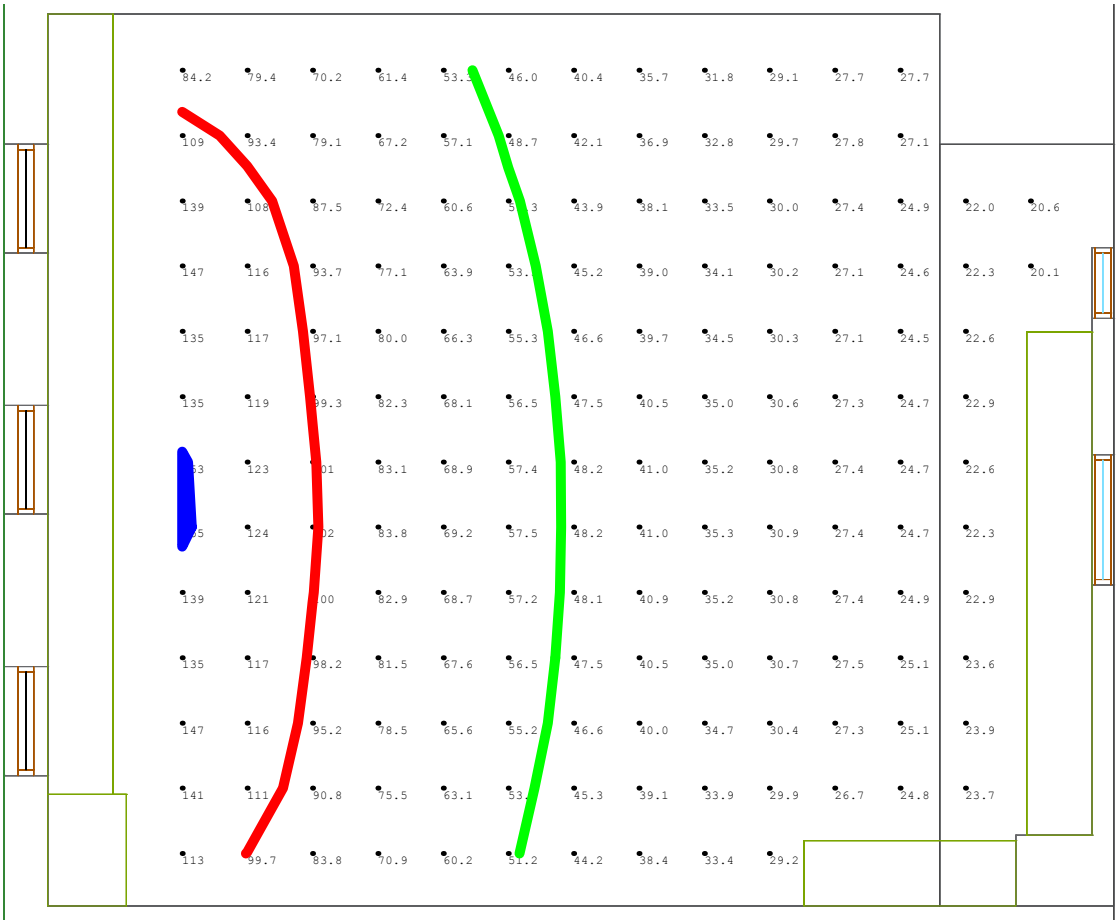
Recommendations: Increase the window to floor area ratio to at least 15%. Exterior shading devices should be used for the direct solar component. Interior lightshelves will work for south facing classrooms. Increase the ceiling height and slope it from the window wall. Shades will be necessary, the ones that come from the bottom up (Meco Shades).

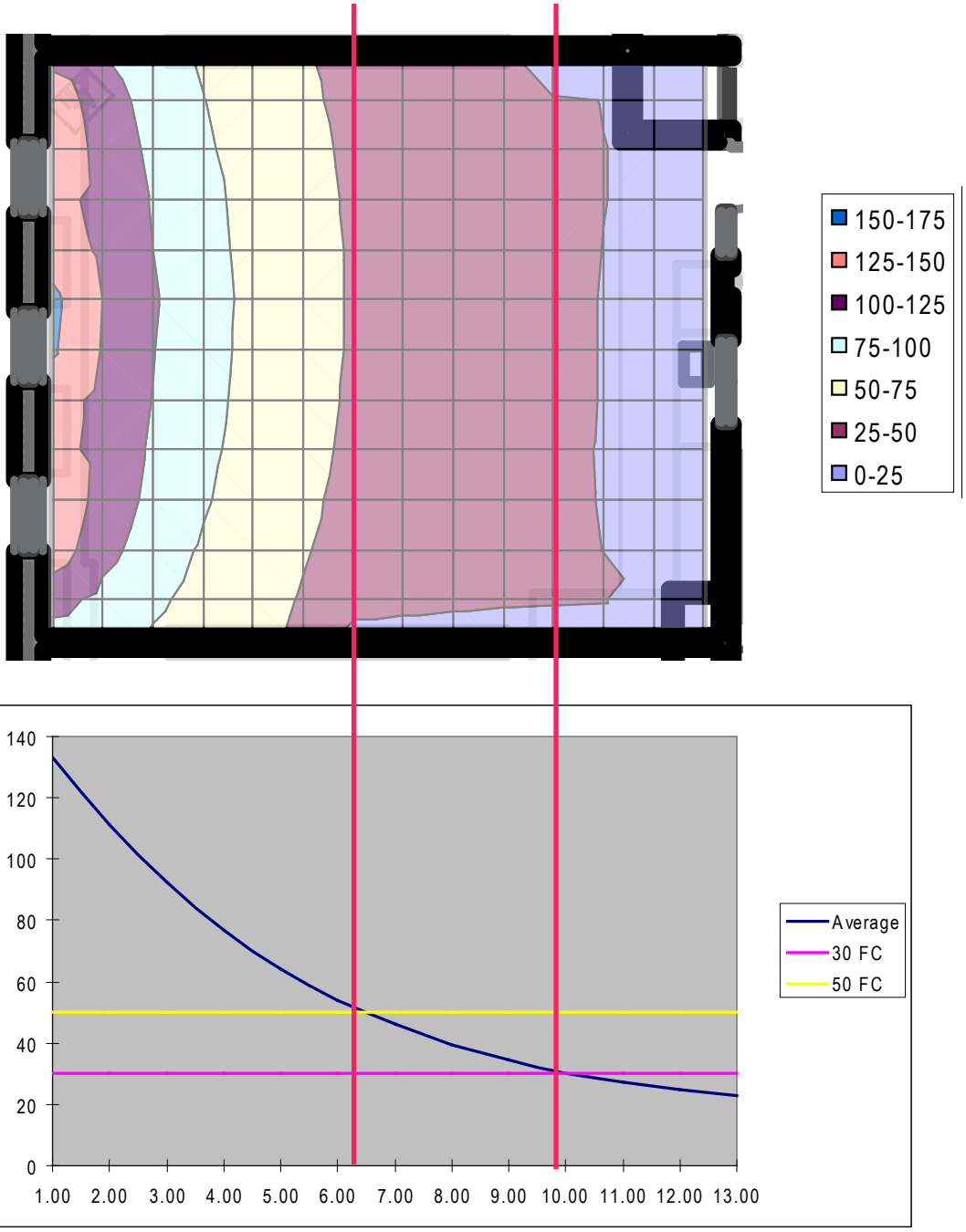
First Floor Southeast Facing

Clear Sky Conditions

Window/Floor Ratio: 5%
Avg: 59 fc
Max: 155 fc
Min: 20 fc
Contrast Ratio: 1:8

See Notes





The first floor southeast facing classrooms have a sufficient amount of daylight under clear sky conditions. However the daylighting strategies are for overcast sky conditions. The target luminance of 30-50 fc occurs deep in the space. The graphs above shows glare and contrast in the space.

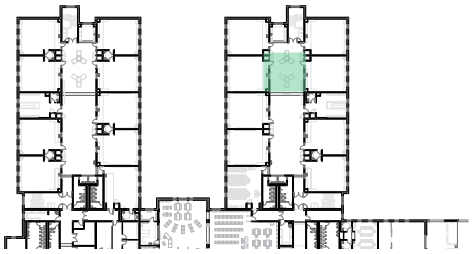
Recommendations: The use of exterior shading devices and light shelves will create a more even distribution of light throughout the space. This will also reduce the glare. Shades will be required.

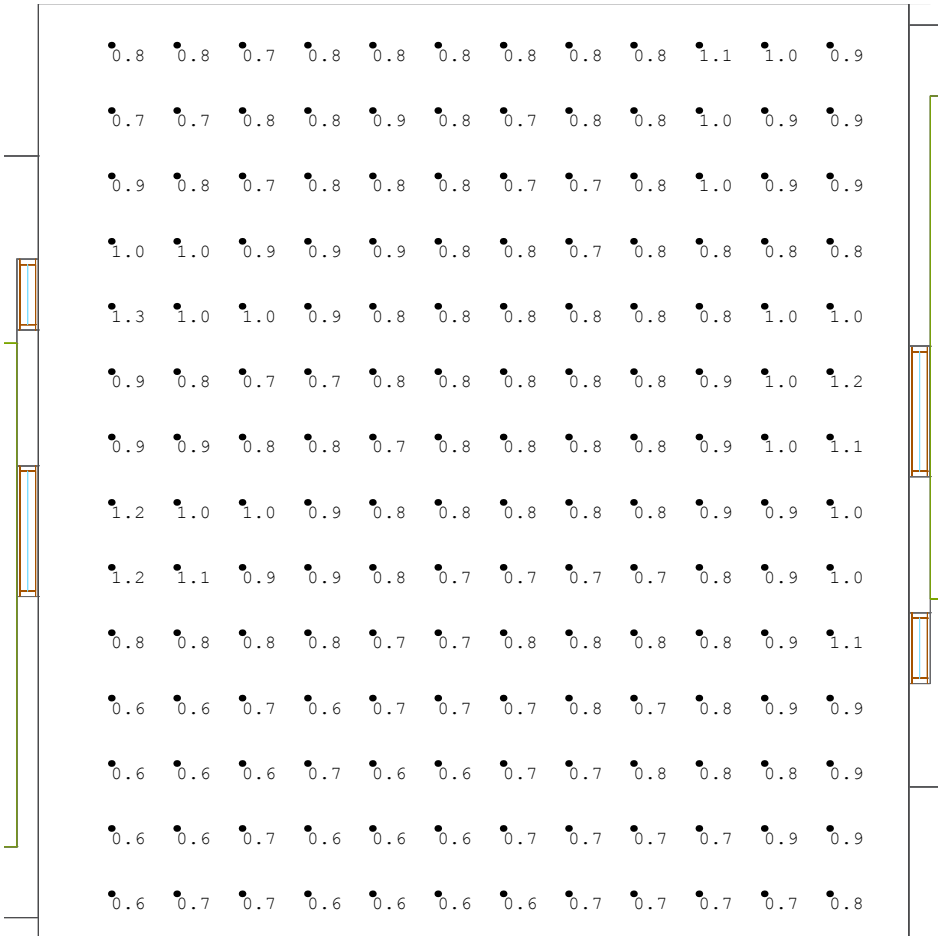
First Floor Work Area

Overcast Sky Conditions

Window/Floor Ratio: 5%
Avg: 1 fc
Max: 1 fc
Min: .5 fc
Contrast Ratio: 1:2

See Notes

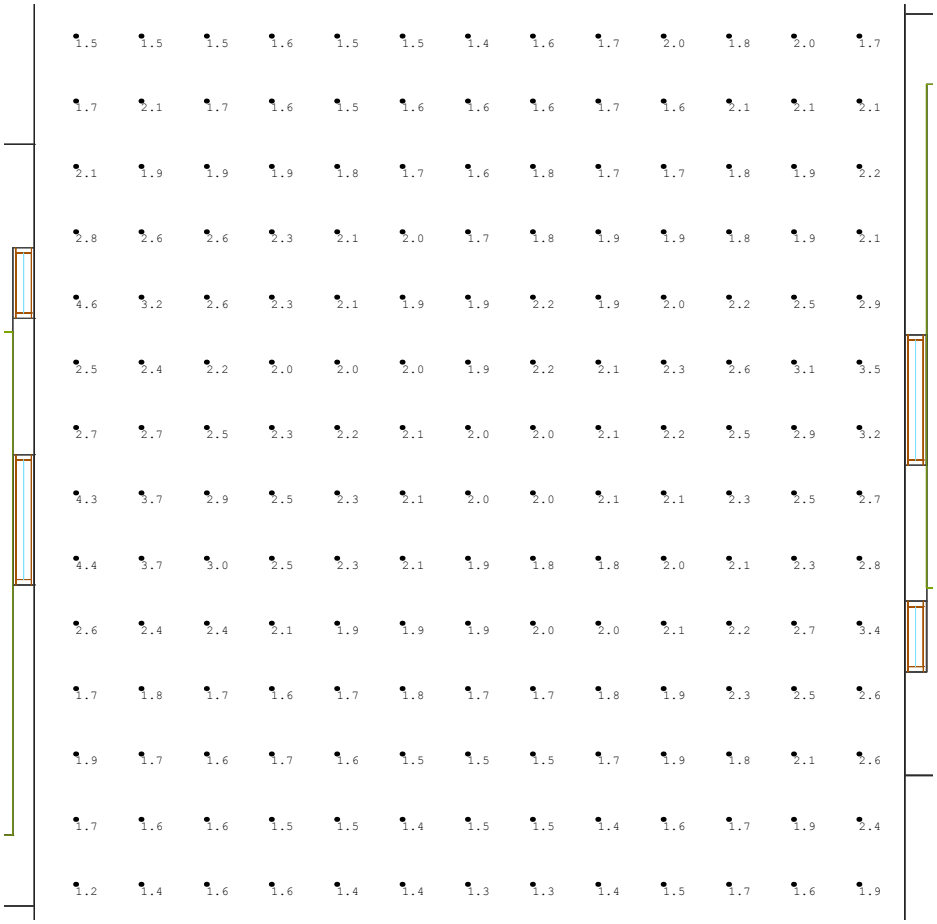




Clear Sky Conditions

Window/Floor Ratio: 5%
Avg: 2 fc
Max: 5 fc
Min: 1 fc
Contrast Ratio: 1:4

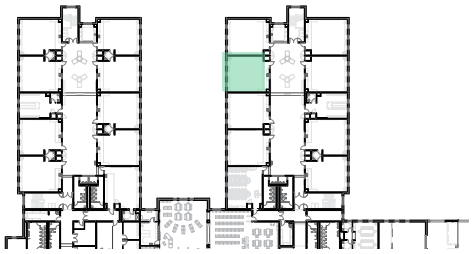
See Notes



The first floor work areas between the classrooms receive little if any light from the exterior. There is no real feasible way to effectively daylight these spaces. This is due to the distance that these spaces are from the exterior and the amount of glazing on the exterior and interior.

Recommendations: There is no real feasible way to effectively daylight these first floor spaces. An increase in some daylight may occur if the amount of daylight is increased in the classrooms.

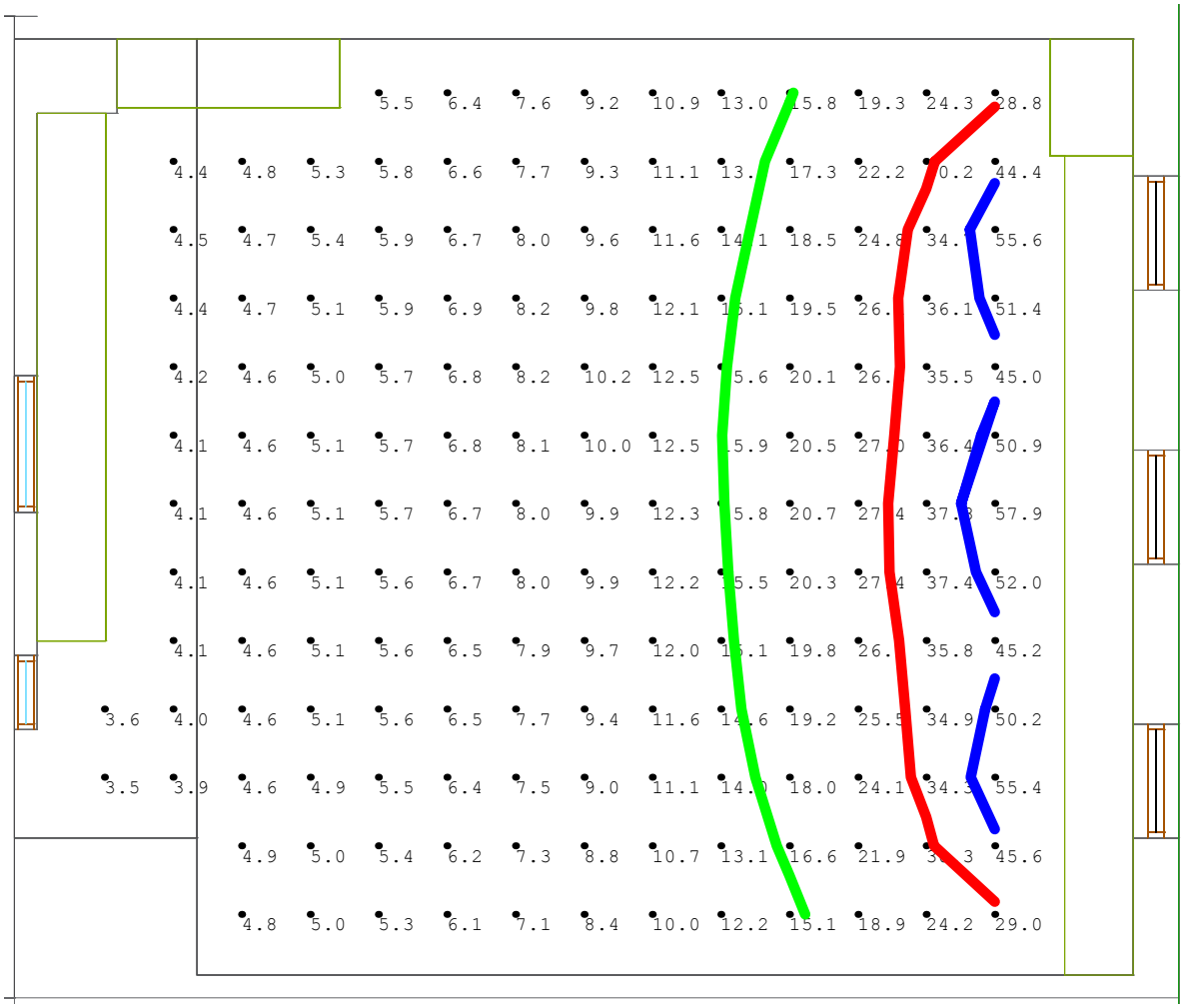
First Floor Northwest Facing

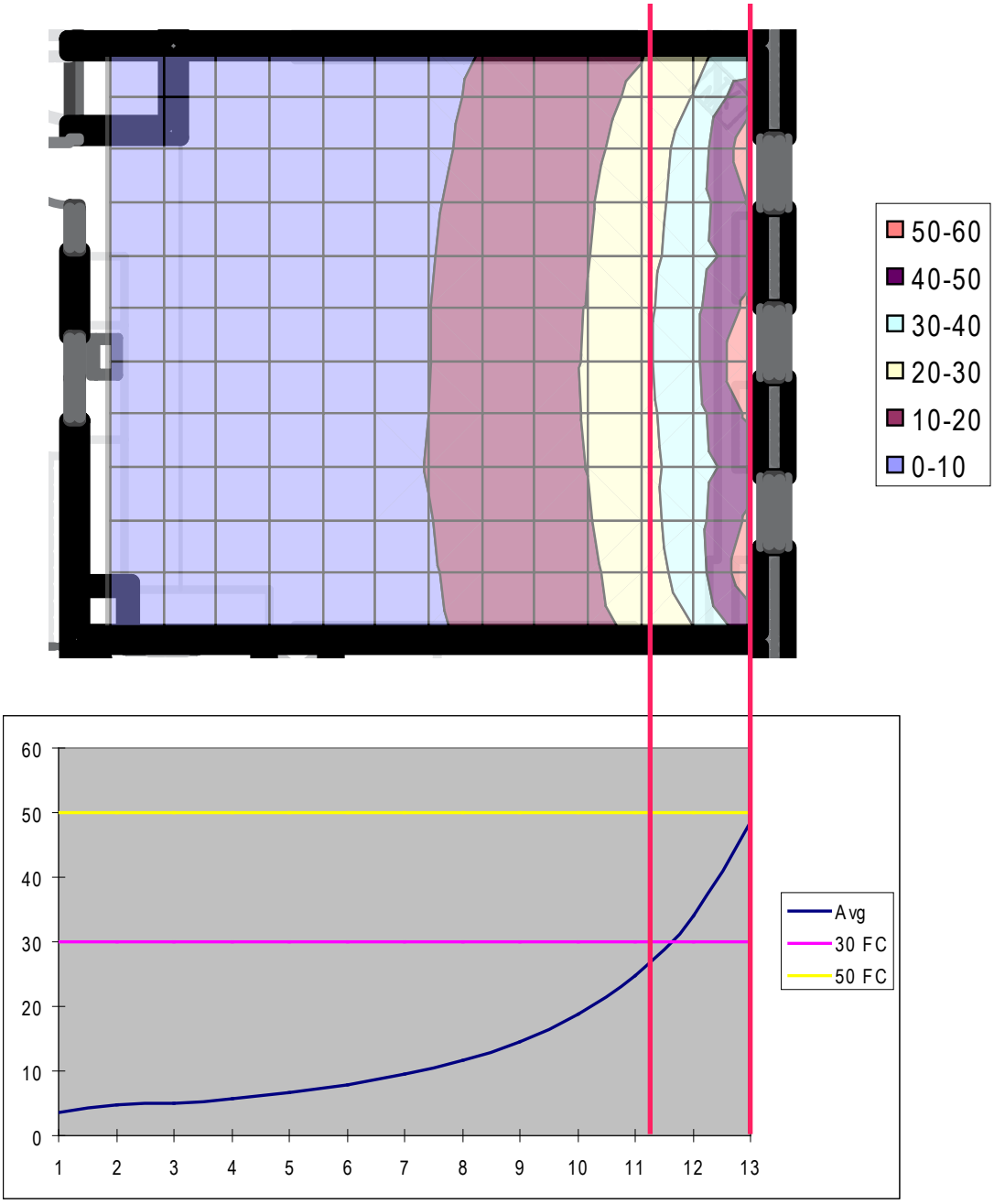


Overcast Sky Conditions

Window/Floor Ratio: 5%
Avg: 15 fc
Max: 58 fc
Min: 4 fc
Contrast Ratio: 1:17

See Notes

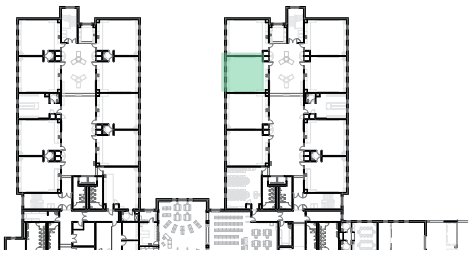




The first floor northwest facing classrooms do not have a sufficient amount of light to effectively daylight the space. The reason being is that there is only a 5% window to floor area ratio. The existing daylight scenario has a lot of glare and contrast. Luminance values drop off steeply at the window wall. The image on the previous page reflects glare and contrast.

Recommendations: Increase the window to floor area ratio to at least 15%, 20% would be optimal. Increase the ceiling height, slope the ceiling from the window wall inward. Shades will be needed for the little direct solar impact later in the day. Light shelves may become feasible depending on the next daylight scenario strategy.

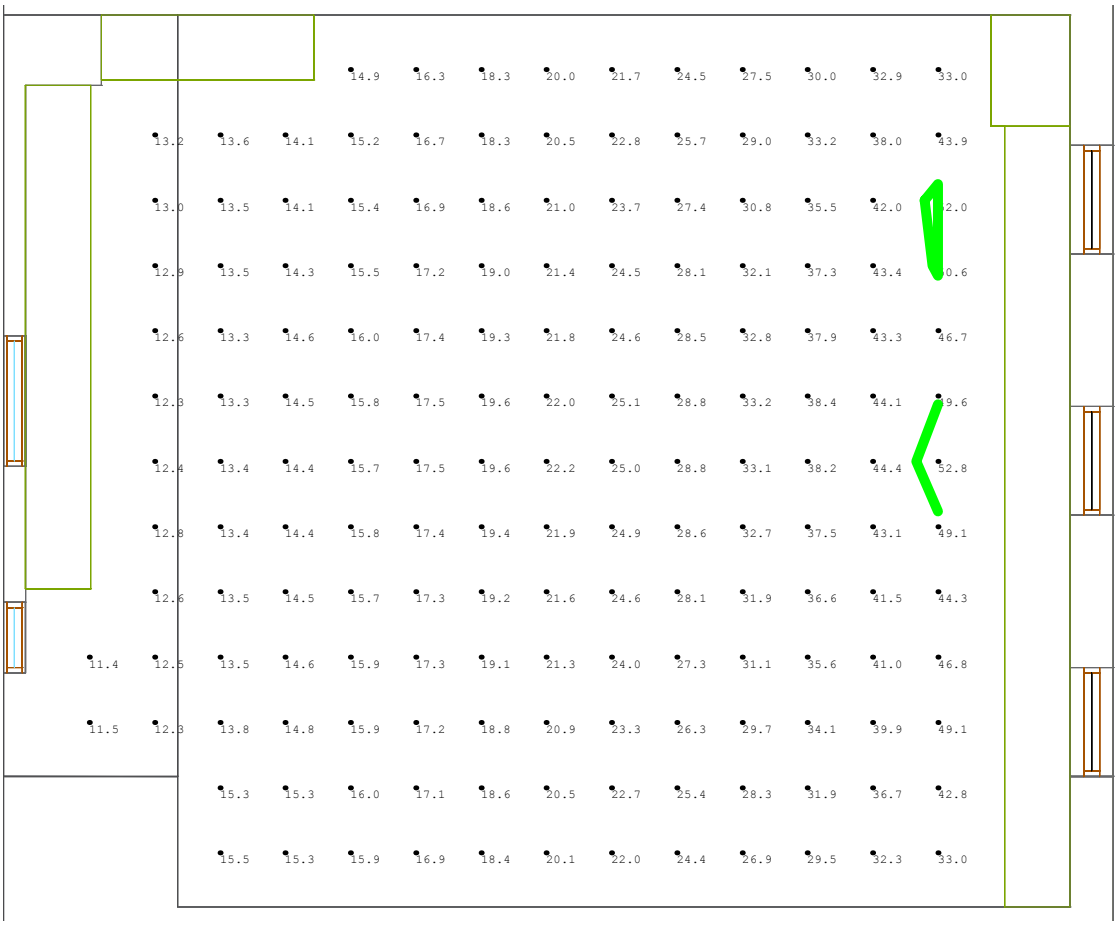
First Floor Northwest Facing

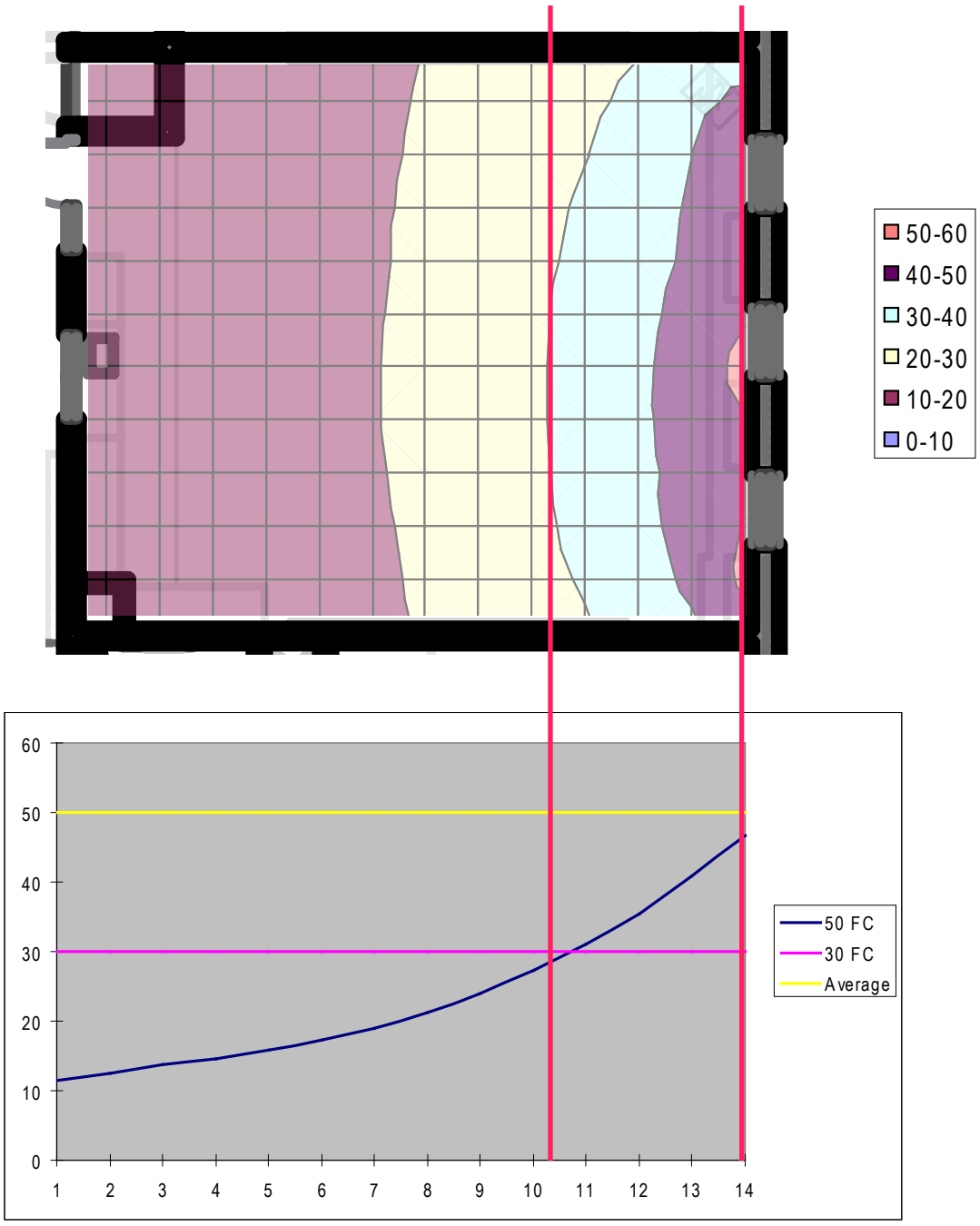


Clear Sky Conditions

Window/Floor Ratio: 5%
Avg: 25 fc
Max: 53 fc
Min: 11 fc
Contrast Ratio: 1:4

See Notes





Even under clear sky conditions, the northwest facing classrooms will not have enough light. Classrooms that face into the courtyards have a lower level than those that don't because of less access to the horizon.

Recommendations; Same as overcast sky conditions.

Other Space Recommendations

Second Floor Classrooms

The conditions and existing lighting conditions are the same as the first.

Recommendations; Same as first floor classrooms. Use clerestories to daylight work area.

Cafeteria

There is not enough glazing to effectively daylight this space. The entrance canopy helps with any direct solar issues.

Recommendations; Use a northeast facing clerestory

Stage Area

Windows along ramp are not needed. Direct solar issues and will cause glare for those looking toward stage.

Recommendations; Remove windows and use elsewhere.

Music Classroom

There is not enough glazin to efffectively daylight the space. Direct solar issues. Glare and contrast.

Recommendations; Incresase the window to floor area ratio. Use exterior shading decvices and interior lightshelves. Blinds will be needed.

Administative Area

Direct solar issues.

Recommendations; Blinds

Media Center/ Library

There is not enough glazing on either floor to effectively daylight the spaces. Some direct solar issues, but this can be handled with blinds.

Recommendations; Increase the glazing area using a high VLT low SHGC glazing. Blinds will be needed. Top lighting could be an option with the second story space.

Gymnasium

Windows on northwest elevation to small to effectively daylight the space. These windows will also cause glare and contrast to those sitting in the bleachers. Direct solar will contact gym floor.

Recommendations; If window configuration does not change use 50% VLT. Increase the amount of glazing and place on both the long sides of the gym. Translucent glazing can be an option. Clerestory could be implemented but must be analyzed.

General Recommendations.

-The goal to daylighting any space should be to obtain 50% of the lighting requirements of the space through the use of daylight. Anything less than this, except for a few large spaces, and the required actions for implementing daylighting become in feasible.

-Use high VLT (70%0 and low SHGC (.3-.4) glazing. Certain daylighting strategies will require specific glazing combinations to provide the best quality of light.

-Internal Reflectance of surfaces: 80-90% ceiling, 70% walls, 40% floors.

-Use at least a 15% window/floor area ratio for south facing spaces and 15-20% for north facing spaces. Clerestories should be 7-10% of the floor area.

-Daylighting and electrical lighting needs to be coordinated together. This allows for the optimal lighting levels and quality. Each compliment one another.

-Luminance levels for classrooms should be about 30 fc. 50 fc is too high.

-Offices should have no more than 50fc for luminance levels.

-The gymnasium should maintain around 30 fc.

-Remove any unnecessary glazing. Stair towers do not need glazing.