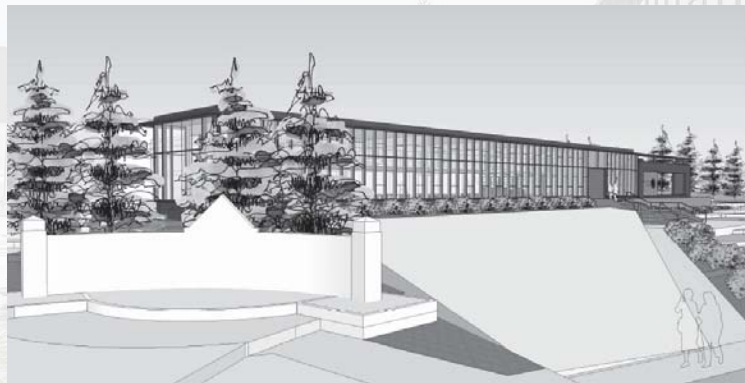


WWAMI Building Performance Analysis

Colten Hoff
Luke Whitbeck
Mai Pham
Mai Anh Doan
Olamide Olorunkosebi

General Building Information



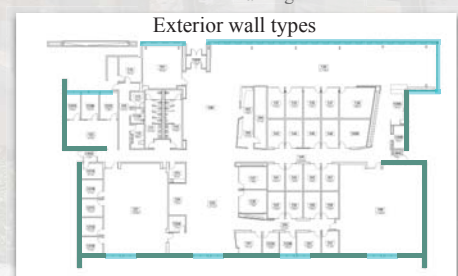
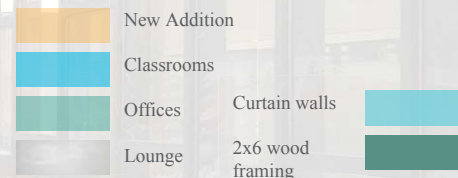
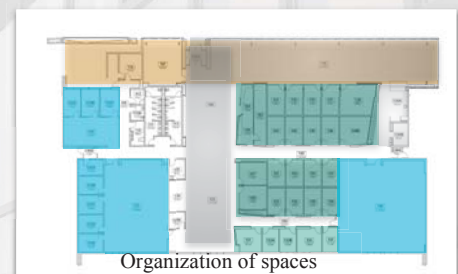
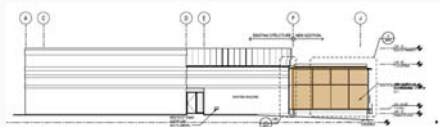
ARCHITECT:
FLAD Architects

LOCATION:
U of Idaho, Moscow, ID

PROJECT TYPE:
2018 renovation & new
addition to existing
education facility

SQ FT:
29,437

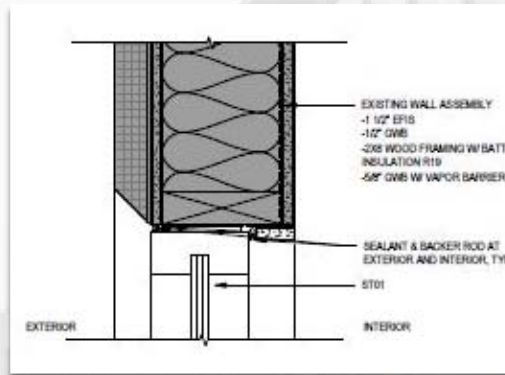
PROJECTED EUI:
44 kBTU/ft²/yr



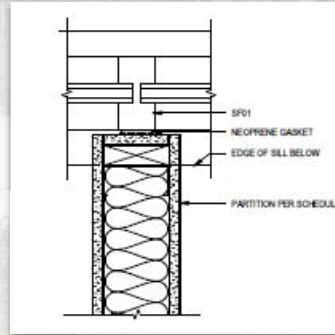
Wall types



Curtain walls
2x6 wood framing



- 1 1/2" EFIS foam w/ concrete stucco finish
- 1/2" GWB(gyp)
- 2x6 wood framing
- BATT insulation(R19)
- 5/8 " GWB(gyp)/vapor barrier

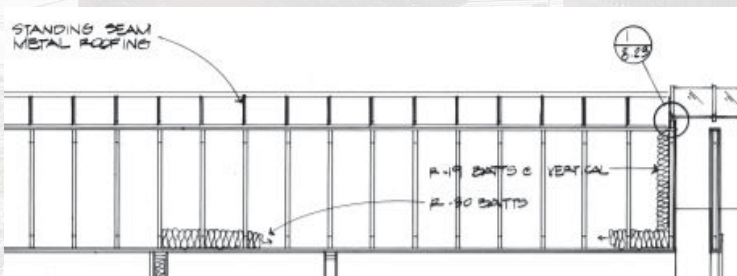
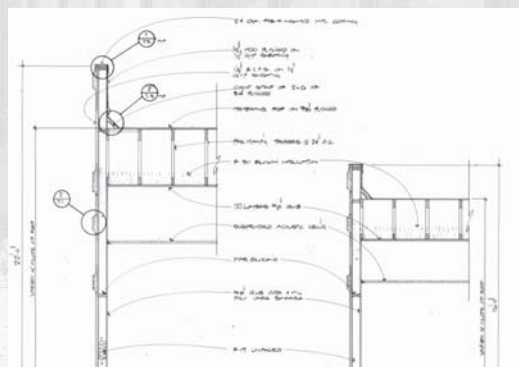
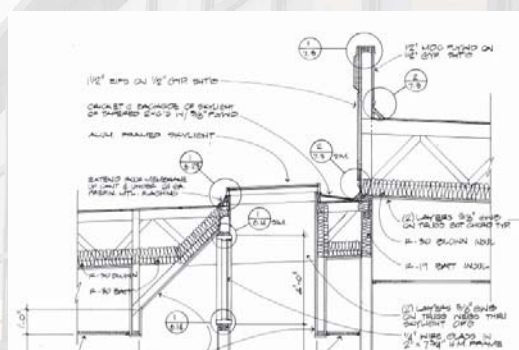


- KAWEER 1600 Curtain wall system
- 2 1/2 "pressure glazing
- 6" anodized aluminum mullions

ROOF/CEILING (Original)

- Membrane roof
- 5/8 plywood
- R30 Blown insulation
- R30 BATT insulation
- 2 layers 5/8" Gyp on truss

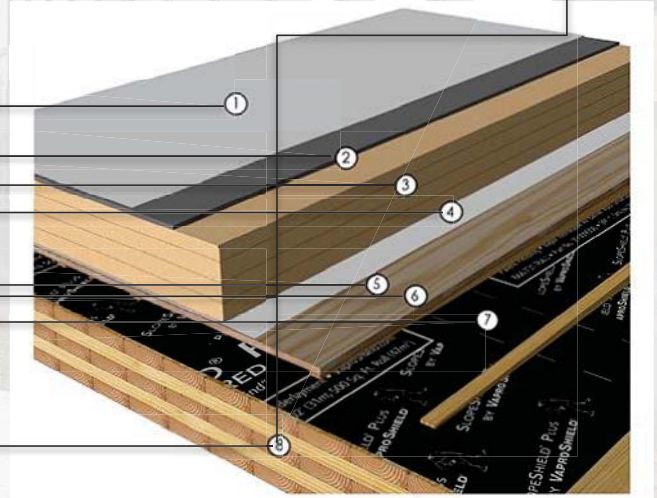
R33



R41.47

ROOF/CEILING (New Addition)

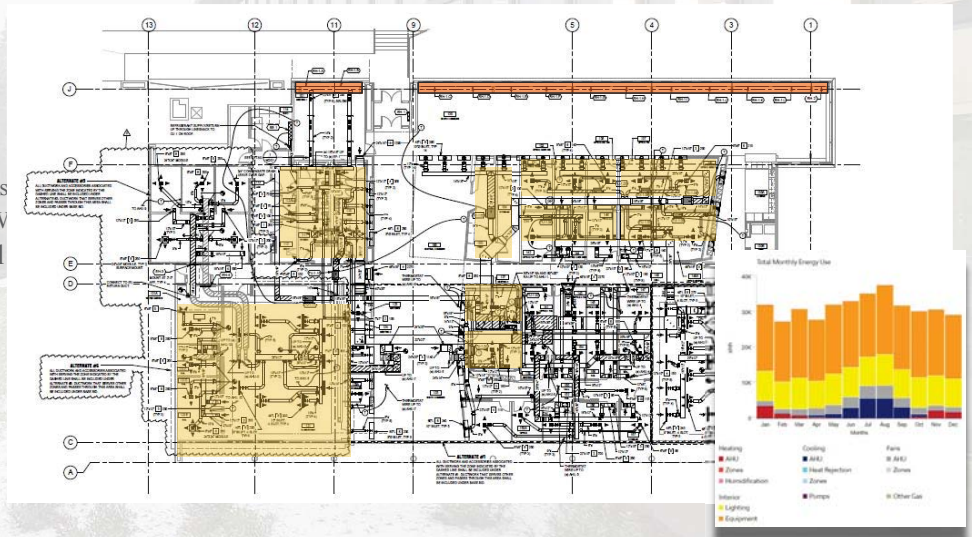
- Roof membrane
- Coverboard
- Continuous rigid insulation
- Air & vapor barrier membrane
- Structural sheathing
- Over Framed vented air cavity
- Vapor permeable roof underlayment
- 7-ply CLT panels(R-11.25)



Heating/Cooling Systems

- Radiant heaters
- Air Handling Unit(208 volts/62.686 KW + 10 additional Units (208 volts/.901KW)
- Terminal Units(for individual control zones)

Individually controlled zones
Single control zone





Hypothesis

- 1.The transparent partitions fail to provide effective daylighting to office spaces.
- 2.The north lounge area is more susceptible to temperature changes due to external conditions
- 3.The skylights along the center corridor do not provide sufficient daylighting to the offices.
- 4.The east/south facing glass wall causes more glare in the morning.

- 
- 1.The translucent partitions fail to provide effective daylighting to office spaces.

Due to the northern location of the glass curtain wall, we suspect that there will not be enough daylight that reaches the front offices.



1.The translucent partitions fail to provide effective daylighting to office spaces.

According to Lighting Design Lab, in order to achieve effective daylighting, the offices need to have about 30-50 foot candles of light

COMMERCIAL OFFICE					
Open Office	40	30 - 50			@30" Above Finished Floor (AFF)
Private Office	40	30 - 50			@30" AFF
Conference Room	30				Matte surface reflectance for the table 40% recommended
Restroom	18	7.5 - 30			
Lunch & Break Room	15	5 - 20			

1.The translucent partitions fail to provide effective daylighting to office spaces.

Experiment:

We measured the lighting in 9 different specified zones around the building At different times a day for multiple days .

Created a model of space and analyzed the sun lighting in ELUM



1.The translucent partitions fail to provide effective daylighting to office spaces.

Data averages taken from the light meter onsite.

LIGHTS ON	SUNNY	SUNNY	CLOUDY	SUNNY
MORNING	Day 1	Day 2	Day 3	Day 4
Area 2	101.2	125.2	153	135
Area 5	30	23.4	30.5	31.5

LIGHTS ON	SUNNY	SUNNY	CLOUDY	NOT KNOWN
NOON	Day 1	Day 2	Day 3	Day 4
Zone 2	150	147	153	128
Zone 5	20	28	30	33

This Shows a huge difference in the amount of sunlight that is reaching these spaces.

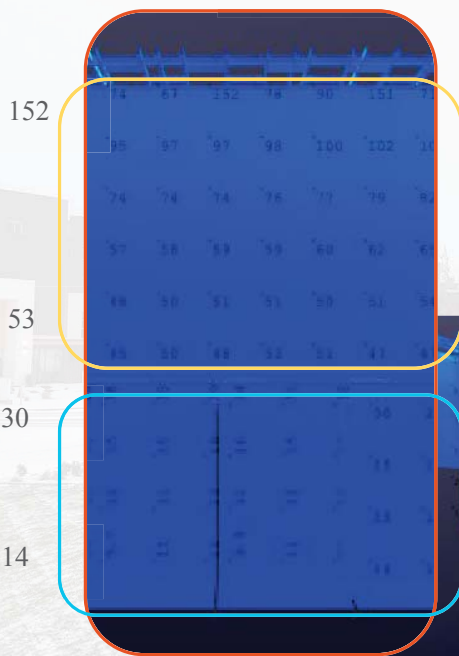


1.The translucent partitions fail to provide effective daylighting to office spaces.

ELUM ANALYSIS

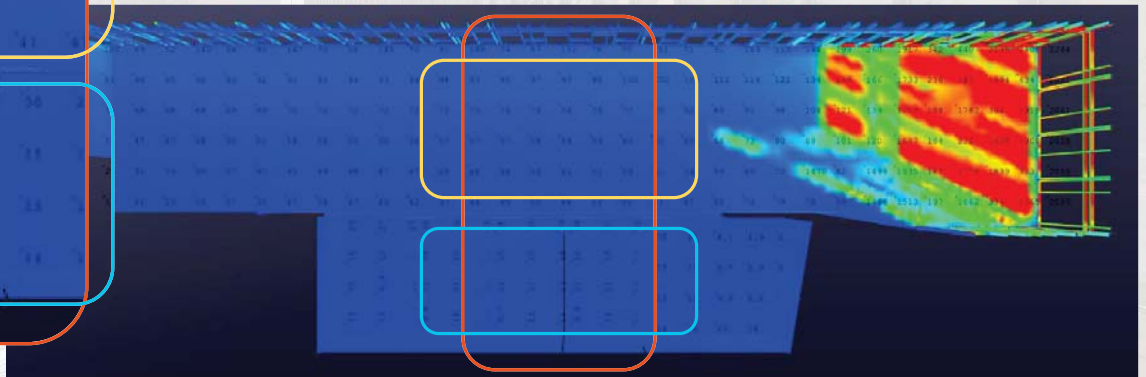
VS

ONSITE ANALYSIS

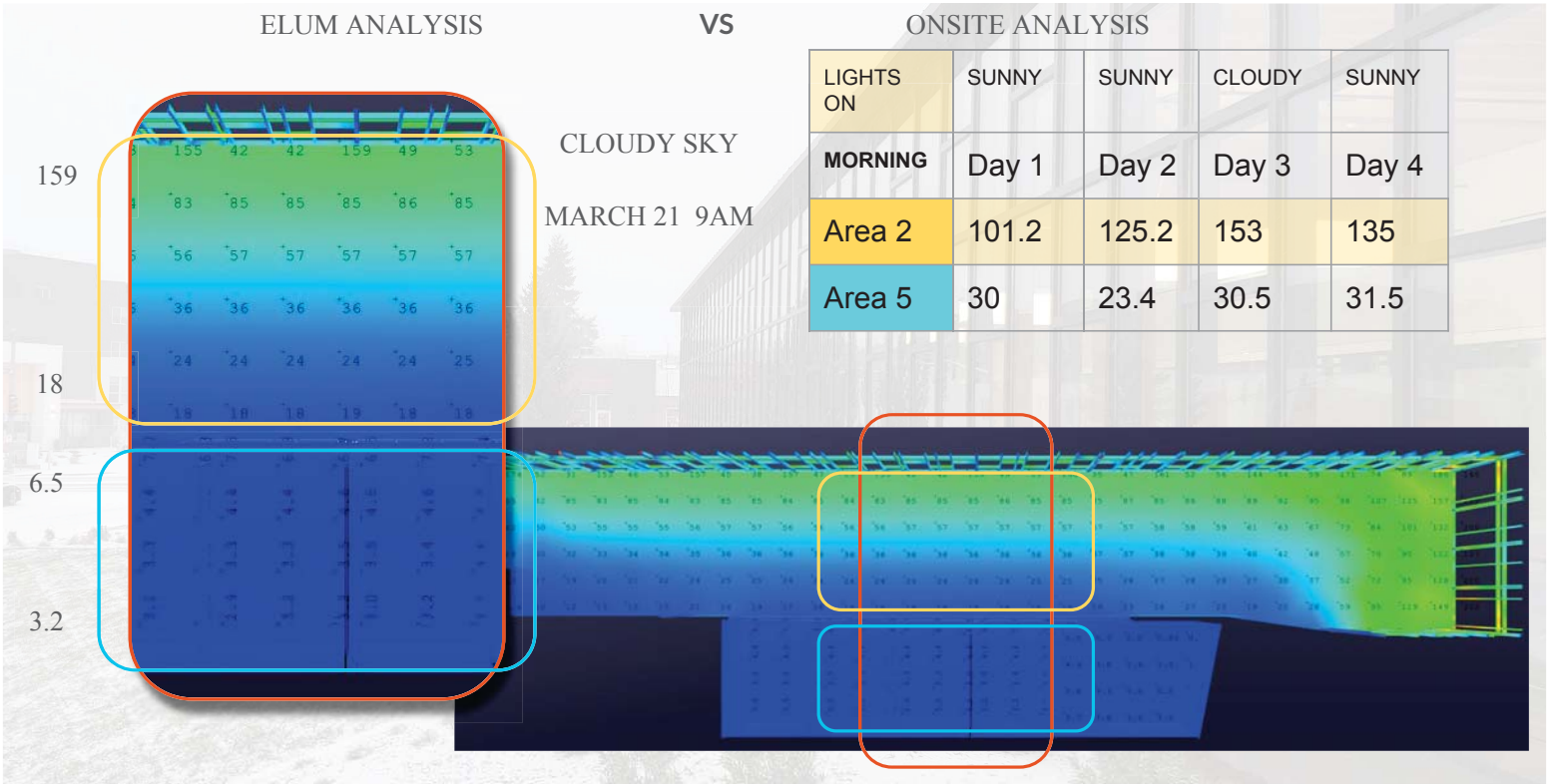


CLEAR SKY
MARCH 21 9AM

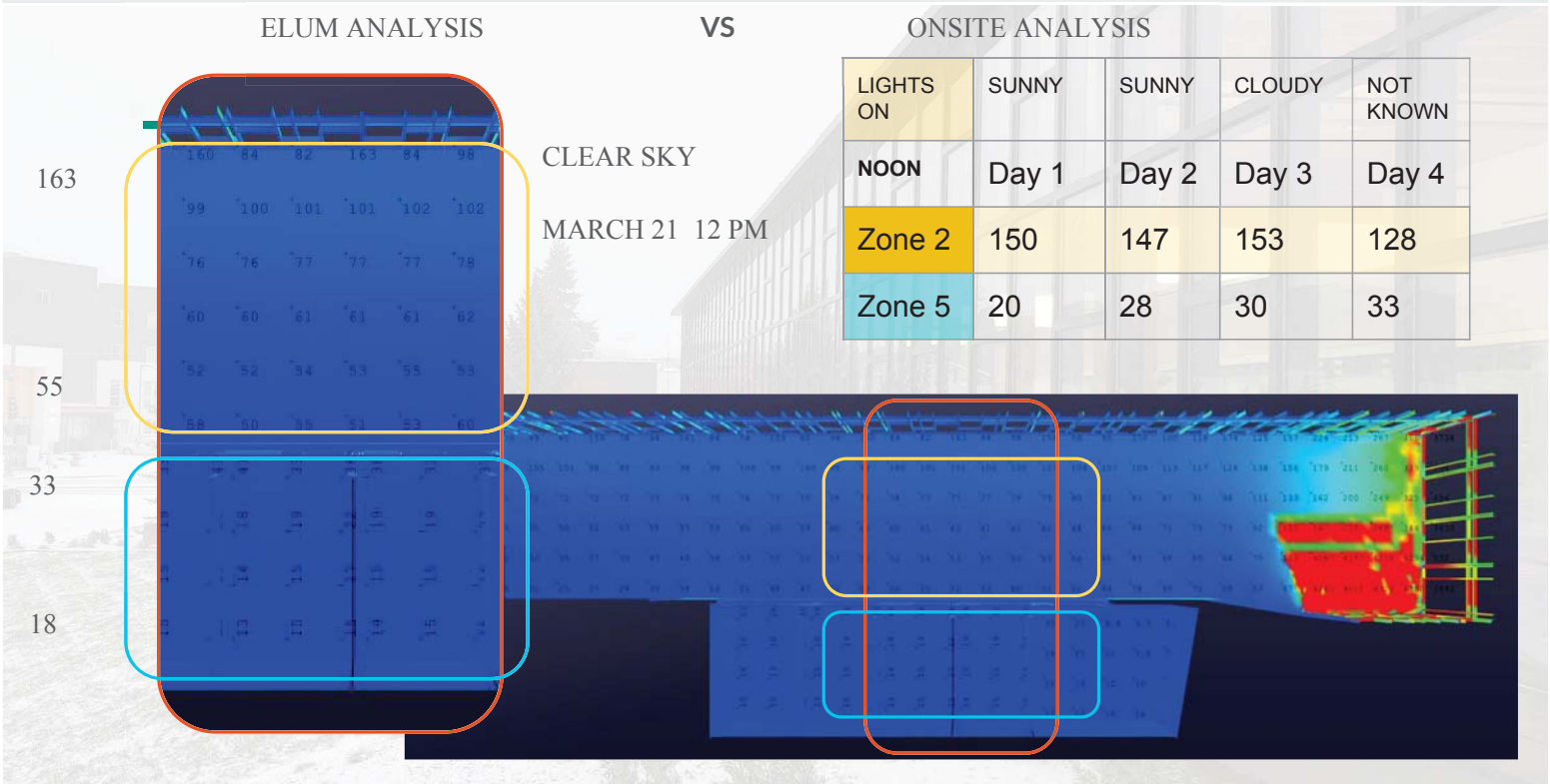
LIGHTS ON	SUNNY	SUNNY	CLOUDY	SUNNY
MORNING	Day 1	Day 2	Day 3	Day 4
Area 2	101.2	125.2	153	135
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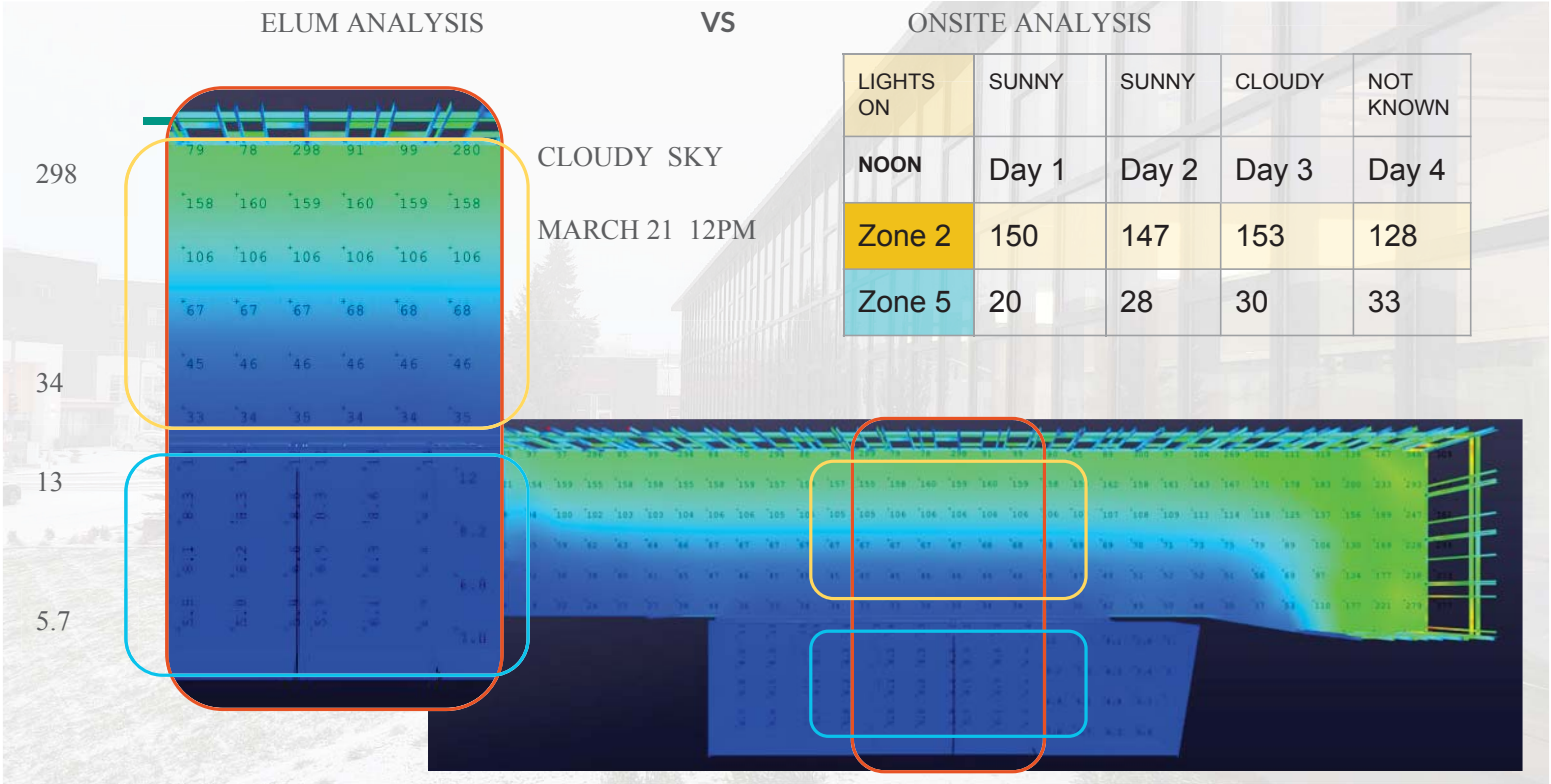
1.The translucent partitions fail to provide effective daylighting to office spaces.



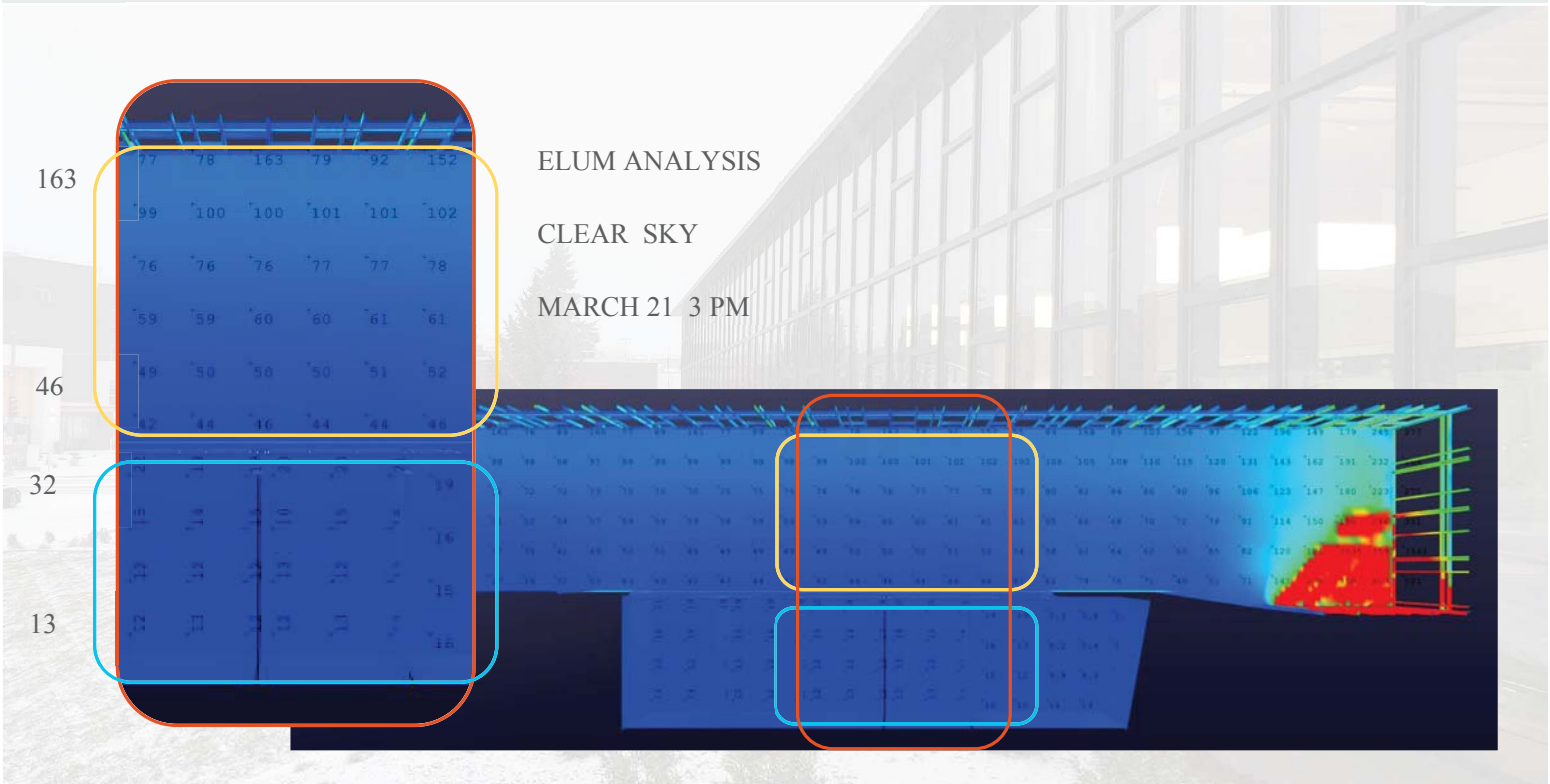
1.The translucent partitions fail to provide effective daylighting to office spaces.



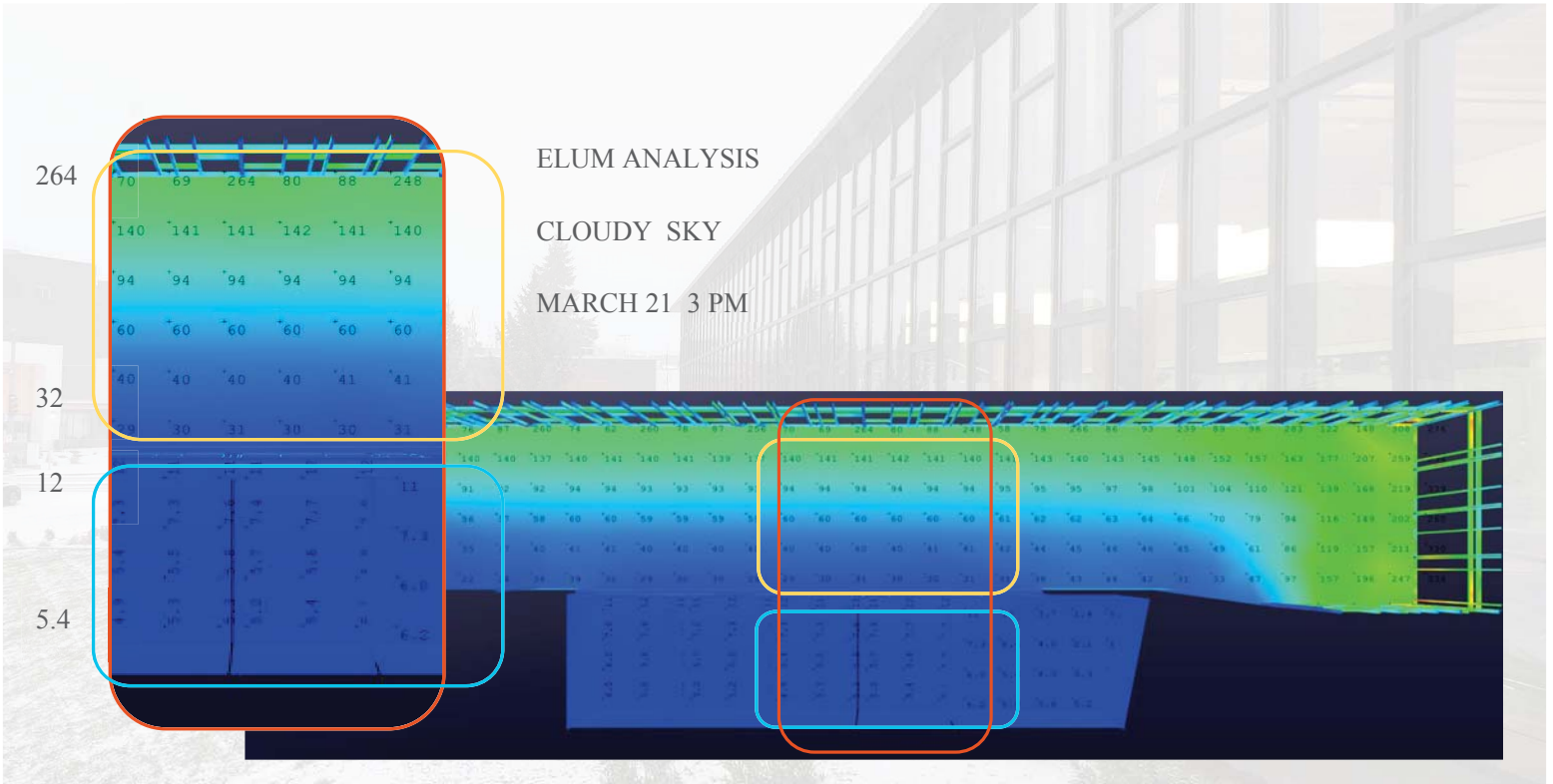
1. The translucent partitions fail to provide effective daylighting to office spaces.



1. The translucent partitions fail to provide effective daylighting to office spaces.



1.The translucent partitions fail to provide effective daylighting to office spaces.



1.The translucent partitions fail to provide effective daylighting to office spaces.

FINDINGS: We found that our hypothesis was for the most part wrong and the natural daylighting in the office spaces was either within range of recommended levels or slightly below.

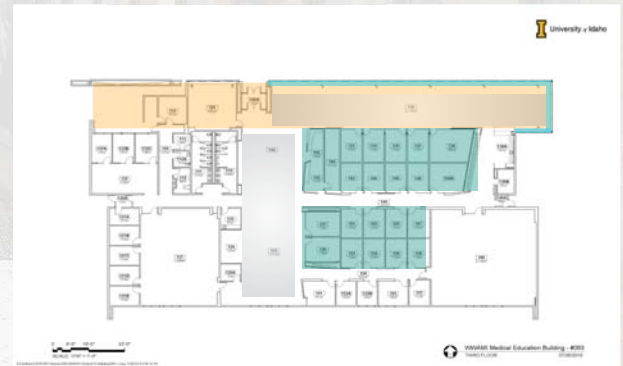
- Towards the back of office spaces natural light is usually slightly below recommended levels-small amount of electric light could easily offset this.
- Easternmost offices get especially dark during morning
- With current lighting system in building when lights are on the levels are far above recommended range- a lighting system which produces lower FC would be better energy wise & for the human senses
- On sunny days there is slightly less natural light in the building than on overcast days

2. The north lounge area is more susceptible to temperature changes due to external conditions.

We think that the north lounge area will suffer the most heat loss/gain. It has an aluminum glass curtain wall on two sides. The majority of the space doesn't receive any direct sunlight except on the East side in the morning which experiences a lot of direct sunlight.

We believe that the rest of the building will maintain a constant temperature while putting less strain on the building systems.

- New Addition
- Offices
- Lounge
- Glass Curtain wall

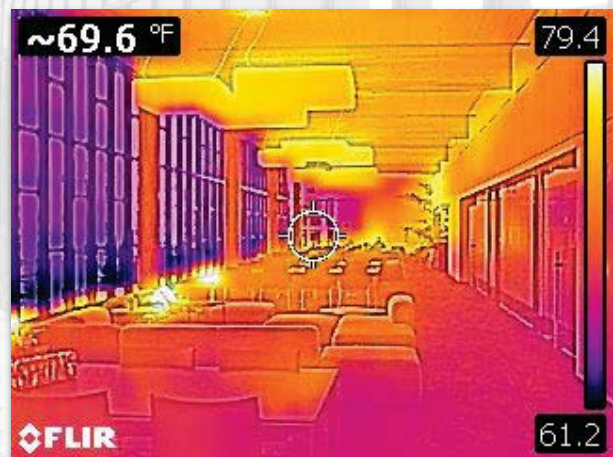


2. The north lounge area is more susceptible to temperature changes due to external conditions

It appears that the glass curtain wall is struggling to hold in heat as it is the coldest surface in the room.

The window mullions are the coldest surface in the room and seem to be thermal bridges allowing the heat from the inside to escape.

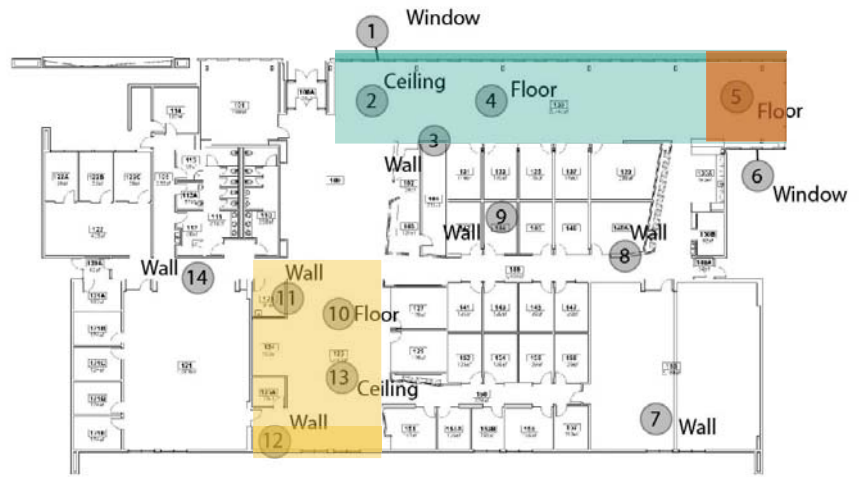
This may result in increased usage of the heating systems and a slightly colder space.



2. The north lounge area is more susceptible to temperature changes due to external conditions

Surface temperatures around the building

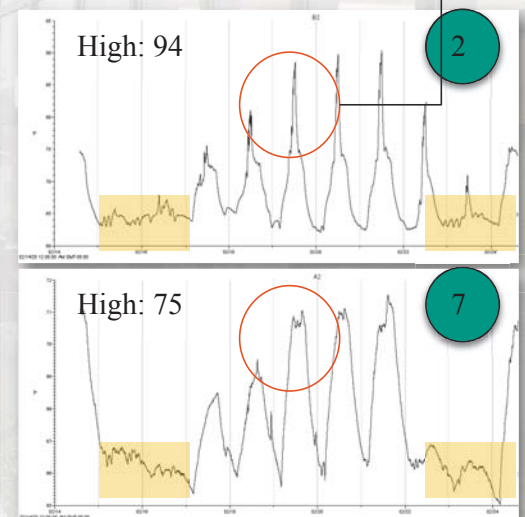
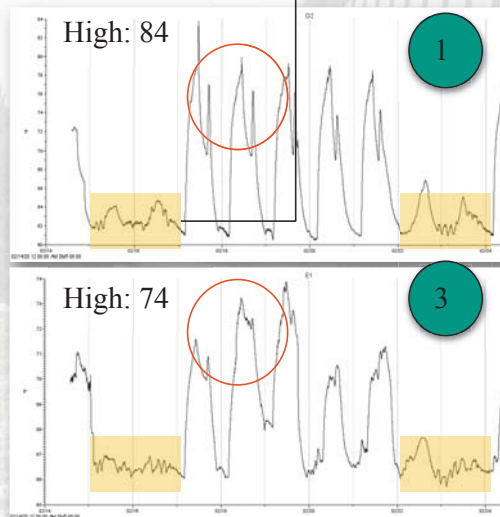
	Day 1	Day 2	Day 3	Day 4
1	69	70	71	72.5
2	75.5	76	74	76.5
3	74	74.5	73.5	75
4	73	72.5	74	92
5	89	76	75.5	91
6	88	85	76	72
7	67	68	70	91
8	72	71	72	72
9	74	75	73	73
10	71	70	71	71
11	71.5	71.5	71.5	72.5
12	75.5	77.5	73.5	75
13	75.5	74.5	73	75.5
14	69	69.5	69.5	77



Temp on weekends shows building without mechanical control systems

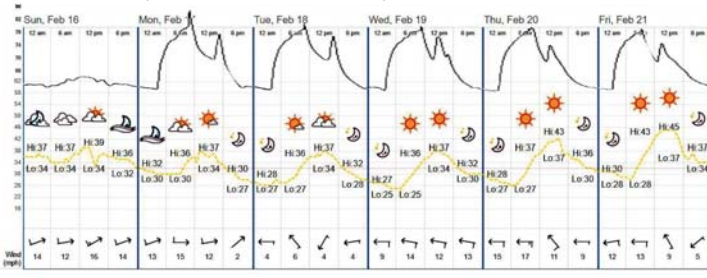
Easternmost room has significantly higher temps

2. The north lounge area is more susceptible to temperature changes due to external conditions

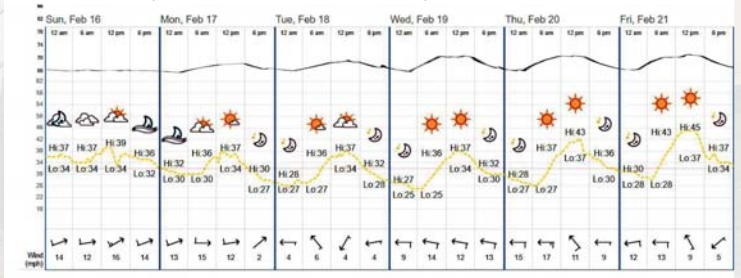


2.The north lounge area is more susceptible to temperature changes due to external conditions

HOBO 1(NORTH LOUNGE)



HOBO 7(CENTER BUILDING)



The north lounge temperature changes throughout the week are much more volatile than center building



2.The north lounge area is more susceptible to temperature changes due to external conditions

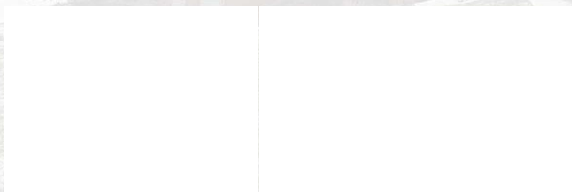
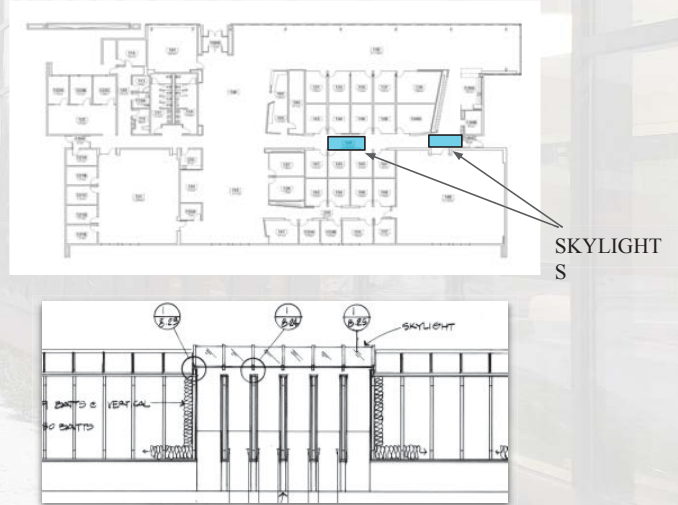
FINDINGS: The north lounge area shows greater variance in temperature compared to other areas of the building due to its northern facing glazing wall. It is apparent, though not certain, that mechanical systems are more heavily used in this space than the rest of the building

- From temperature readings, we were able to determine that the aluminum mullions on the curtain wall behave as thermal bridges that let out heat from inside the north lounge.
- The eastern part of the north lounge where direct solar gain is possible has the most dramatic variance in temperatures in the space with temperatures reaching over 90 degrees on the floor and work surfaces compared to low 70's elsewhere in building.
- The buildings mechanical systems work especially hard in the northern lounge to maintain an even temperature compared to elsewhere.

3.The skylights along the hallway do not provide sufficient daylighting to the offices along it.

There are two skylights that allow daylight to get into the office hallway. We assume that the main purpose of having the skylights is to provide an amount of daylight to the hallway.

However the skylights' ability of delivering sufficient daylighting to the offices along the hallway should be considered as a skeptical statement.



3.The skylights along the hallway do not provide sufficient daylighting to the offices along it.

Illuminance data (in fc) measured by light meter in Feb 2020.

	SUNNY	SUNNY	SLIGHTLY CLOUDY	CLOUDY
	Day 1	Day 2	Day 3	Day 4
Area 6	65	20	44.1	23
Area 7	4.1	4.3	5.9	22

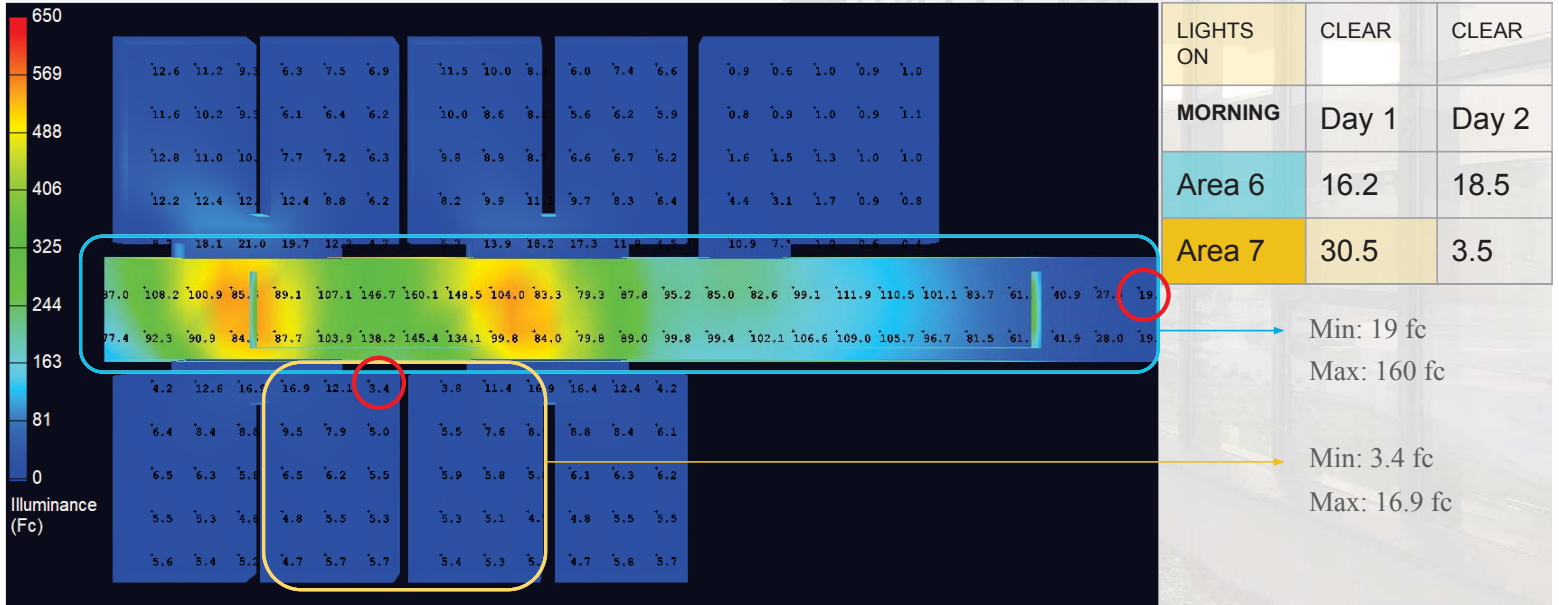
When we compare the hallway under the skylights to the interior of the offices, it shows that they don't get a sufficient amount of daylight from the skylights.



3.The skylights along the hallway do not provide sufficient daylighting to the offices along it.

Agi32 – DAYLIGHT STUDY

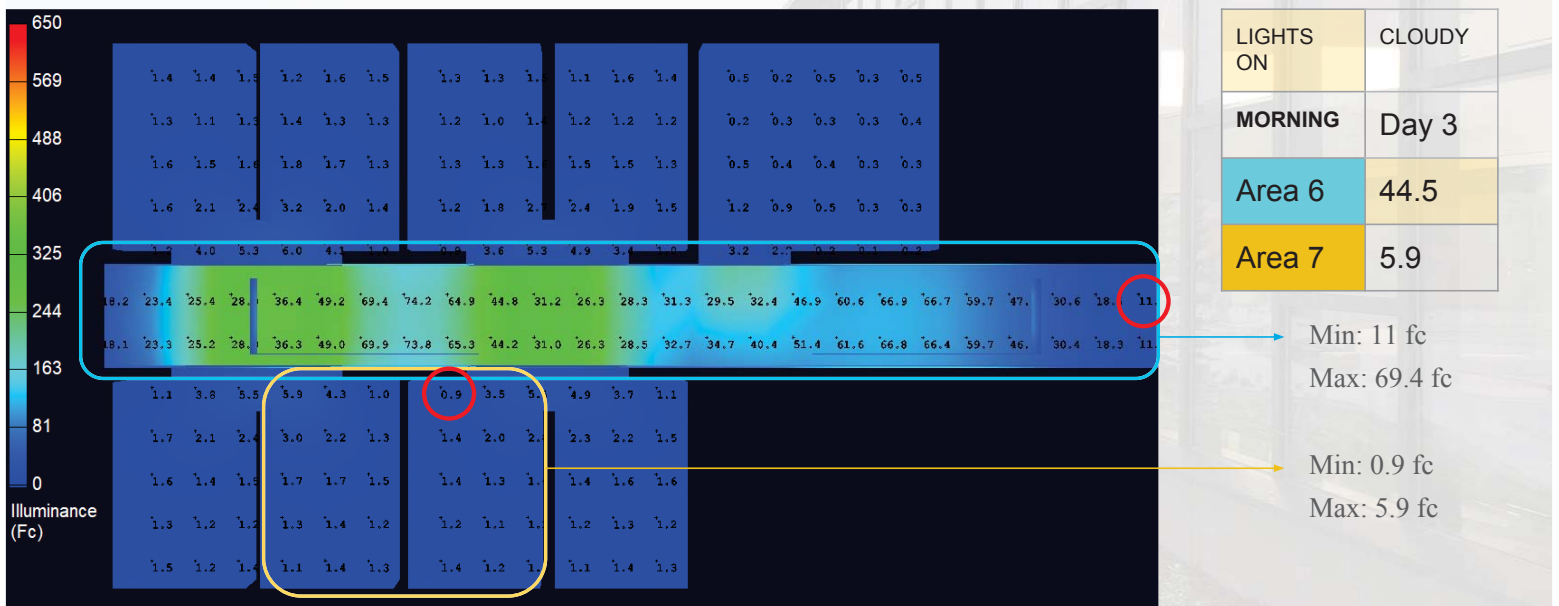
CLEAR SKY CONDITION - FEB 21 - 9AM



3.The skylights along the hallway do not provide sufficient daylighting to the offices along it.

Agi32 – DAYLIGHT STUDY

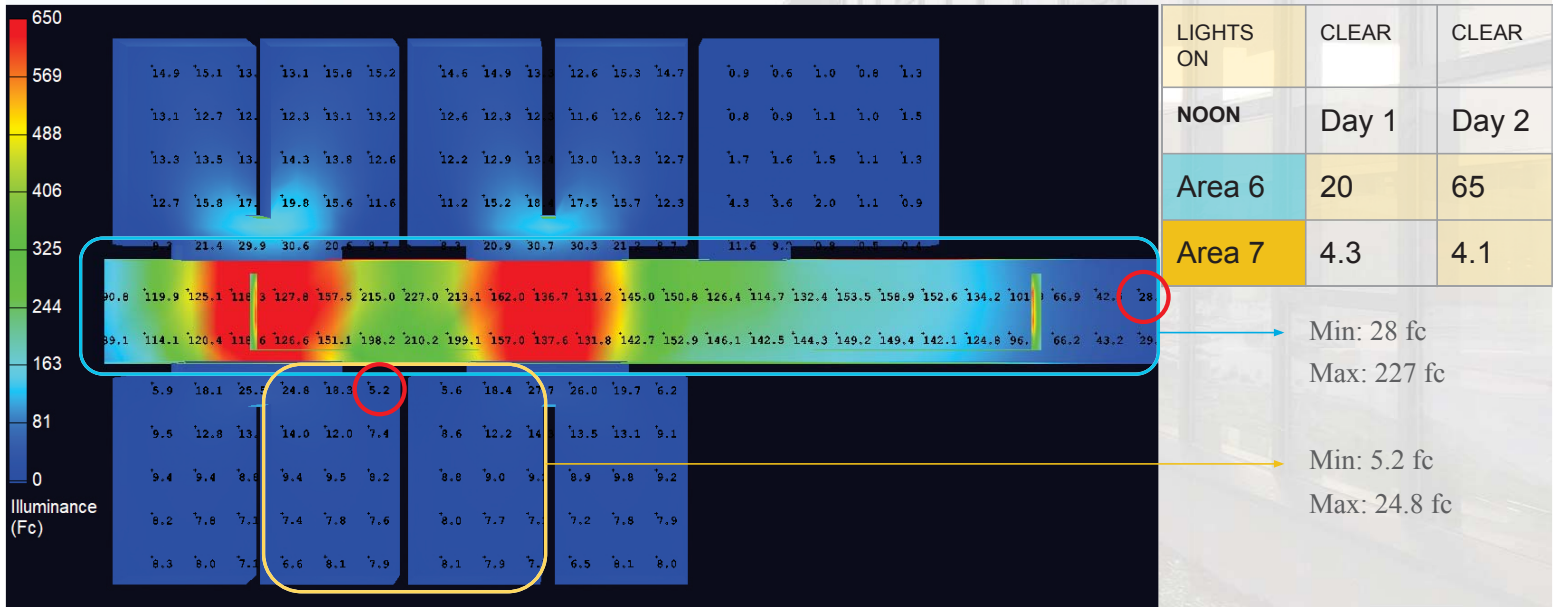
OVERCAST SKY CONDITION - FEB 21 - 9AM



3.The skylights along the hallway do not provide sufficient daylighting to the offices along it.

Agi32 – DAYLIGHT STUDY

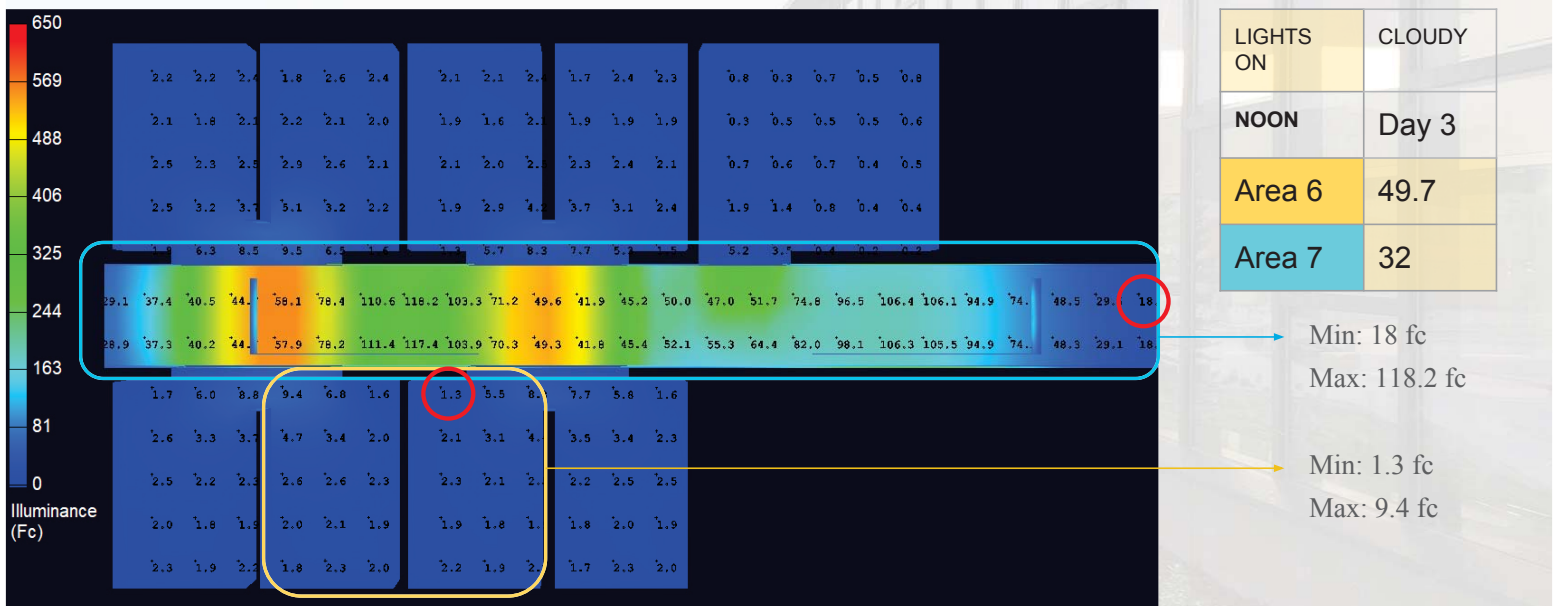
CLEAR SKY CONDITION - FEB 21 – 12PM



3.The skylights along the hallway do not provide sufficient daylighting to the offices along it.

Agi32 – DAYLIGHT STUDY

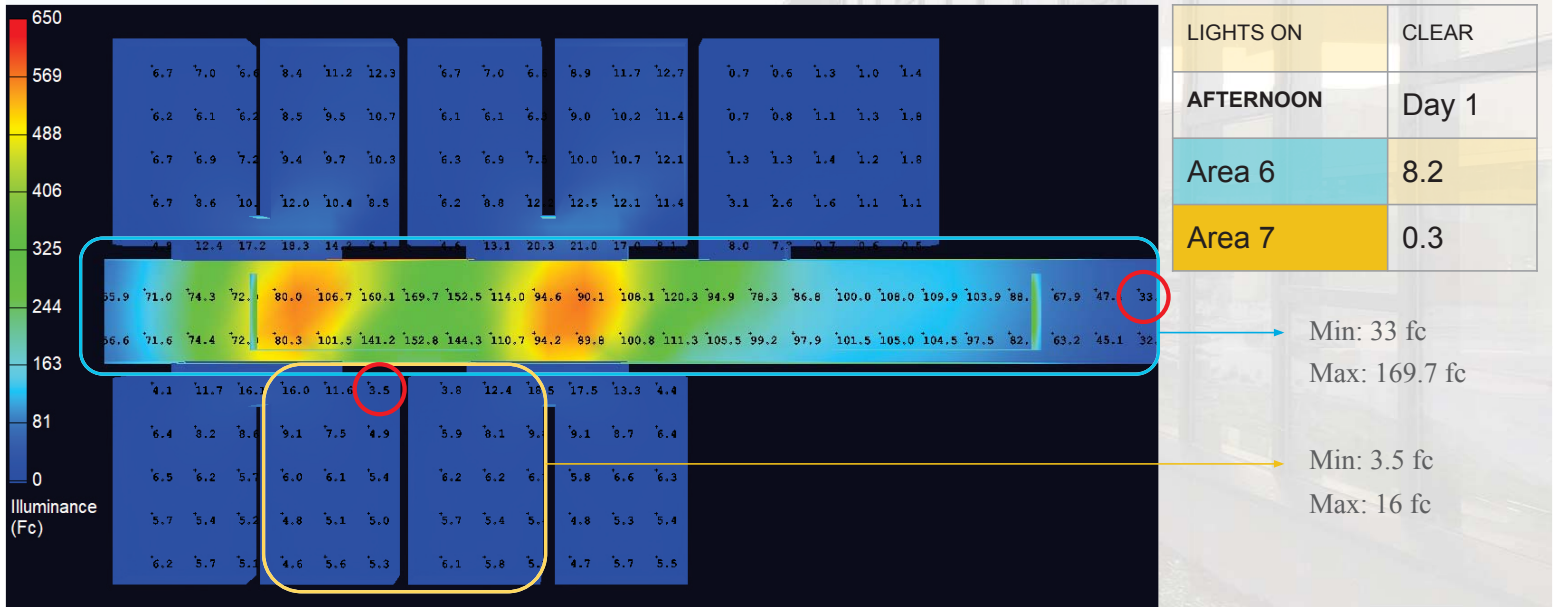
OVERCAST SKY CONDITION - FEB 21 – 12PM



3.The skylights along the hallway do not provide sufficient daylighting to the offices along it.

Agi32 – DAYLIGHT STUDY

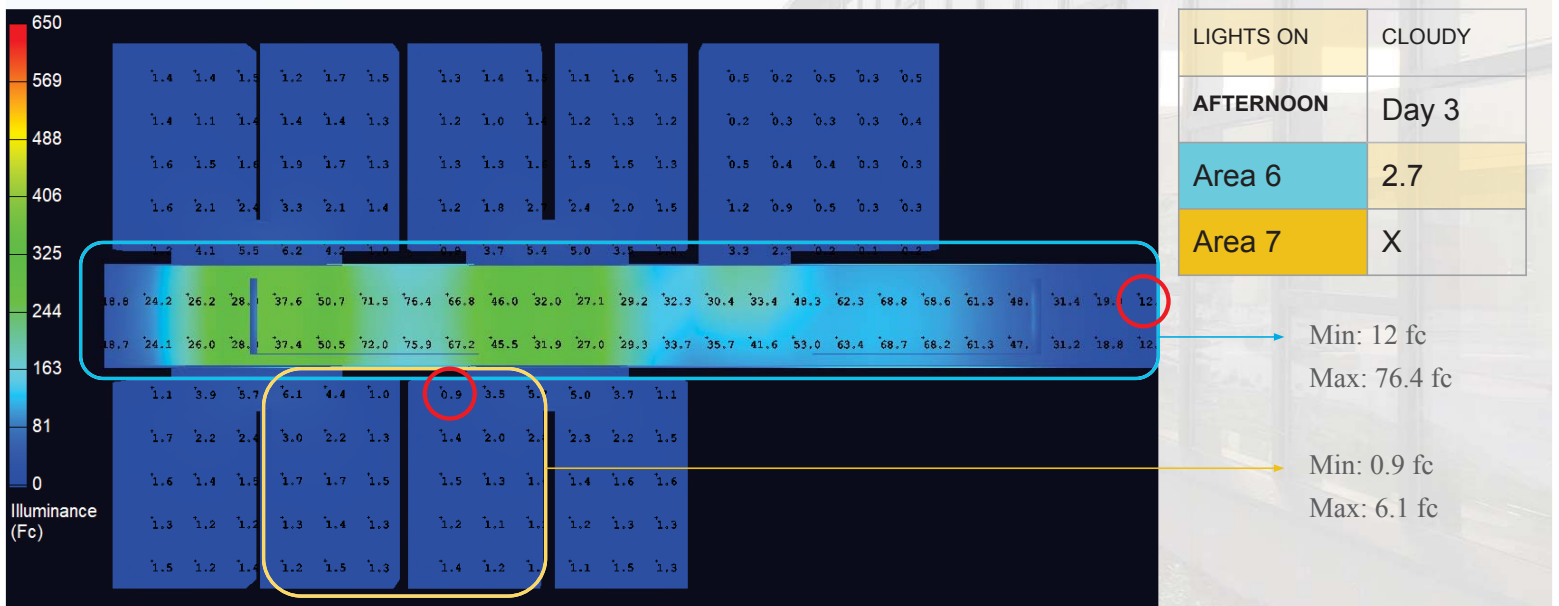
CLEAR SKY CONDITION - FEB 21 – 3PM




3.The skylights along the hallway do not provide sufficient daylighting to the offices along it.

Agi32 – DAYLIGHT STUDY

OVERCAST SKY CONDITION - FEB 21 – 3PM






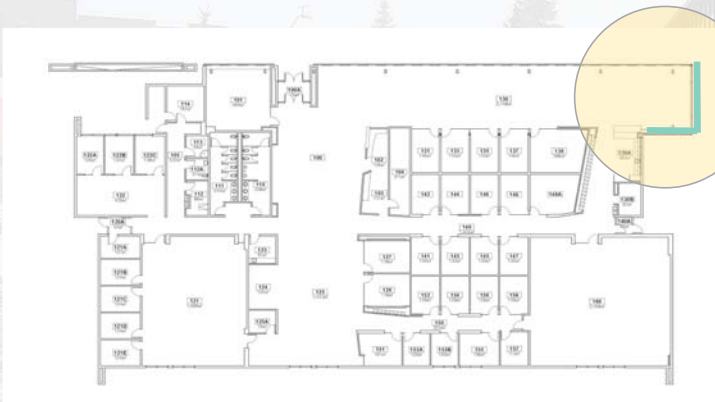
3. The skylights along the hallway do not provide sufficient daylighting to the offices along it.

FINDINGS: The experiments taken place by both methods prove that the skylights only provide sufficient daylighting for the hallway and insufficient daylighting for the offices.

- The fact that levels of daylighting in the hallway are always excessively higher than the recommended illuminance range for corridor area (10 fc) under clear sky condition. It still has more than needed daylighting during overcast noon time and only experiences sufficient daylight during overcast morning and afternoon time (11-12 fc). This findings could be the based line for setting an appropriate scheme of electric lighting for the hallway and saving energy.
- However the skylights are not helping in delivering enough daylight to sufficiently light up the offices even under clear noon sky. The dependence on electric lighting is highly required to sufficiently light up this area.



4. The east/south facing glass walls cause more glare in the morning than afternoon.



The Eastern section of the front lounge area is surrounded by glass walls on 3 sides. It gets a lot of direct sunlight in the morning. Due to the amount of direct sunlight that area gets, we assumed that it would produce more uncomfortable amounts of glare earlier in the morning and lessen throughout the day.

4. The east/south facing glass walls cause more glare in the morning than afternoon.

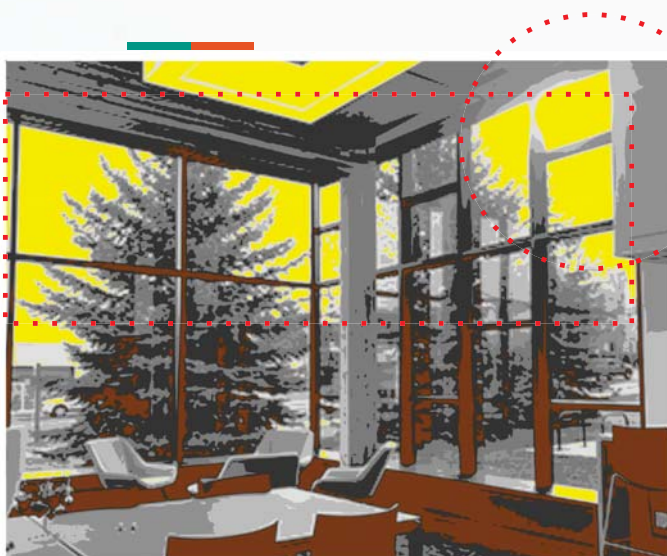


Sunny day - 9:30am

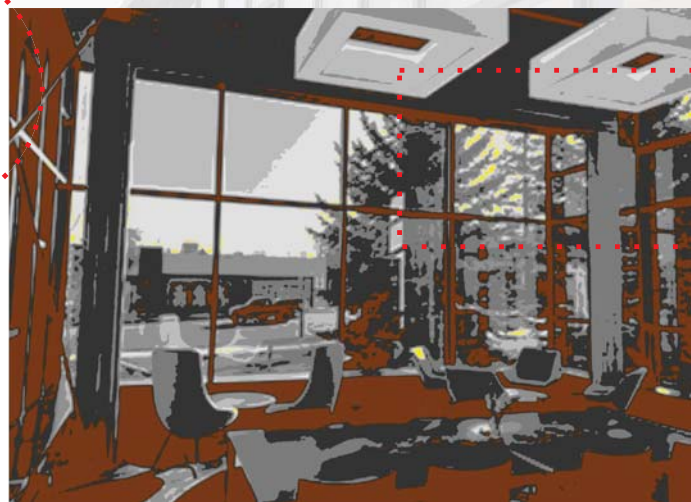


Cloudy day-10:00am

Cuplite Graphic- Sunny day



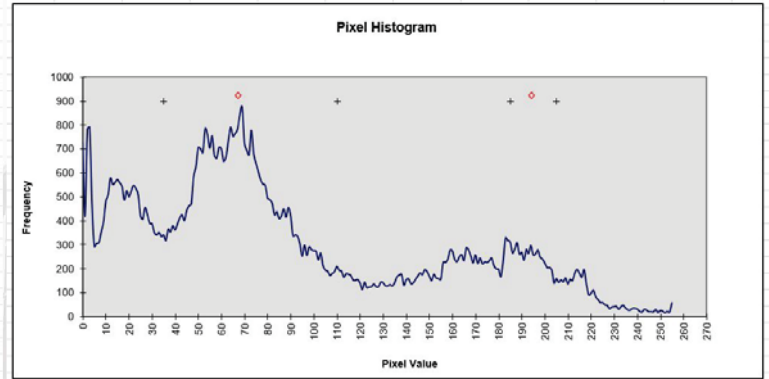
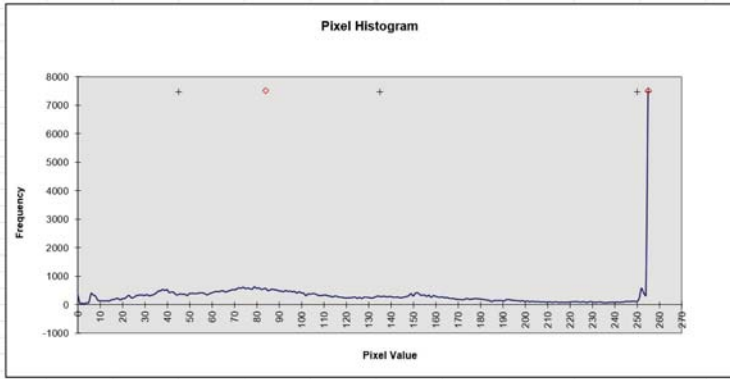
Cuplite Graphic- Cloudy day



- 240-280
- 200-240
- 160-200
- 120-160
- 80-120
- 40-80
- 0-40

Cuplite Statistic - Sunny day / morning

Cuplite Statistic - Cloudy day/ morning



Overall Image		Individual Pixel	
Weighted Ave Pixel Intensity	139.29	Individual Pixel Value	130
Total Number of Pixels	76800	Corresponding Luminance	291.89 footlamberts
Background Bell Curve		Spike	
Low End Pixel Value	45	Low End Pixel Value	250
High End Pixel Value	135	High End Pixel Value	255
Background Median Value	84	Spike Median Value	255
Number of Background Pixels	36359	Number of Spike Pixels	9068
Background Percentage of View	47.34 %	Spike Percentage of View	11.81 %

Overall Image		Individual Pixel	
Weighted Ave Pixel Intensity	102.55	Individual Pixel Value	130
Total Number of Pixels	76800	Corresponding Luminance	201.75 footlamberts
Background Bell Curve		Spike	
Low End Pixel Value	35	Low End Pixel Value	185
High End Pixel Value	110	High End Pixel Value	205
Background Median Value	67	Spike Median Value	194
Number of Background Pixels	37434	Number of Spike Pixels	5177
Background Percentage of View	48.74 %	Spike Percentage of View	6.74 %

Spike to Background Ratio
 Median Spike to Median Background
 Schlier Glare ?

3.04 TO 1
YES

Spike to Background Ratio
 Median Spike to Median Background
 Schlier Glare ?

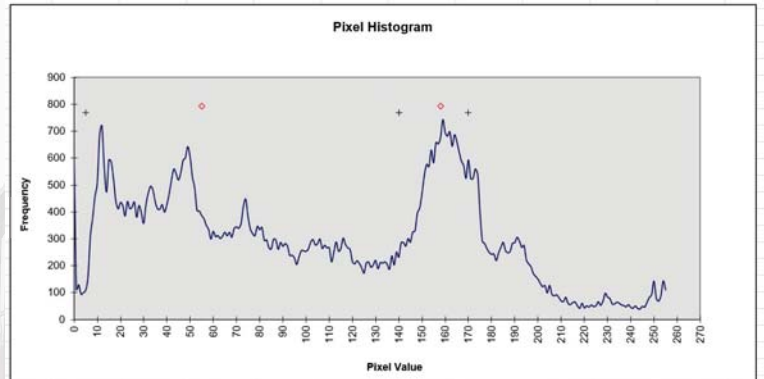
2.90 TO 1
MAYBE



The brightest areas come from surrounding buildings not the sky



Cuplite- Afternoon on Sunny day




Overall Image		Individual Pixel	
Weighted Ave Pixel Intensity	121.39	Individual Pixel Value	130
Total Number of Pixels	76800	Corresponding Luminance	163.36 footlamberts
Background Bell Curve		Spike	
Low End Pixel Value	5	Low End Pixel Value	140
High End Pixel Value	140	High End Pixel Value	170
Background Median Value	55	Spike Median Value	158
Number of Background Pixels	47057	Number of Spike Pixels	16206
Background Percentage of View	61.27 %	Spike Percentage of View	21.10 %

Spike to Background Ratio
 Median Spike to Median Background
 Schlier Glare ?

2.87 TO 1
MAYBE

The actual ratio is lower



4. The east/south facing glass walls cause more glare in the morning than afternoon.

FINDINGS: There is more glare on a sunny day than there is on a cloudy day.

- On cloudy days sky produces little to almost no glare in the space
- Work spaces could be quite uncomfortable to work in on sunny days
- Should consider shading strategy on east/south facing curtain walls in north lounge



Conclusions

1. The transparent partitions fail to provide effective daylighting to office spaces.

The Glass partition walls provide some daylighting to the offices but not a comfortable amount.

2. The north lounge area is more susceptible to temperature changes due to external conditions

The North lounge is much more susceptible to temperature fluctuations related to outdoor weather conditions than any other space in WWAMI. This is thought to result in greater usage of systems throughout the year

The building systems are very good at running with consistency and working during the buildings busiest hours

3. The skylights along the center corridor don't provide enough daylighting to the office spaces.

The innermost offices are not well daylit while the skylights are over good for lighting the hallway.

4. The east/south facing glass wall causes more glare in the morning.

The East and South facing glass wall cause most glare (and heat) in the morning on sunny day. It is more comfortable on cloudy days and in the afternoon.