B3 GUIDELINES

Daylighting

June 2023

OUTLINE

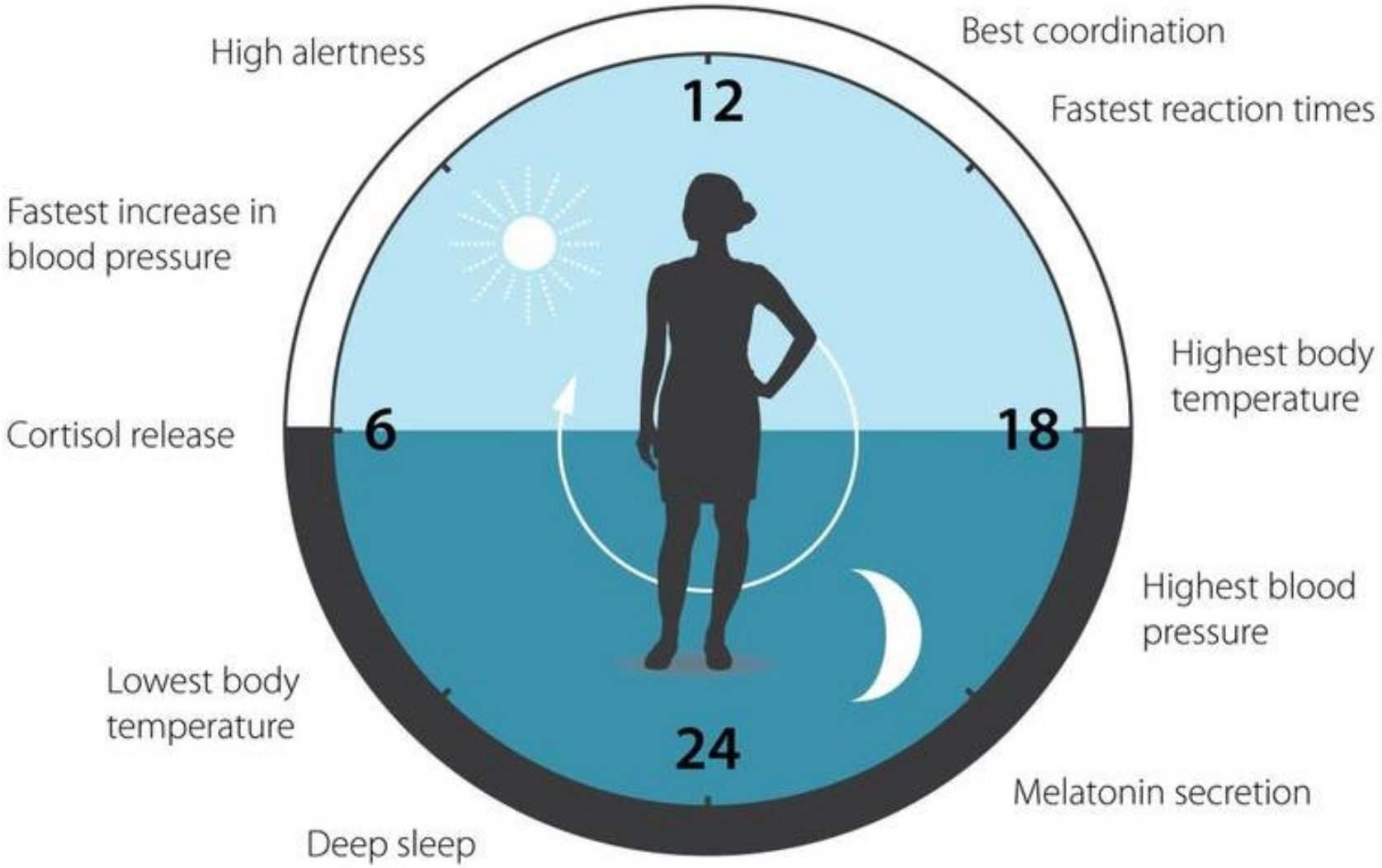
1. **GUIDELINE I.5C – DAYLIGHTING LEVELS: INTENT & APPLICABILITY**
2. REGULARLY OCCUPIED SPACE
3. GLARE CONTROL
4. DAYLIGHT UTILIZATION
5. DAYLIGHT DESIGN OVERVIEW

GUIDELINE I.5: LIGHTING AND DAYLIGHTING

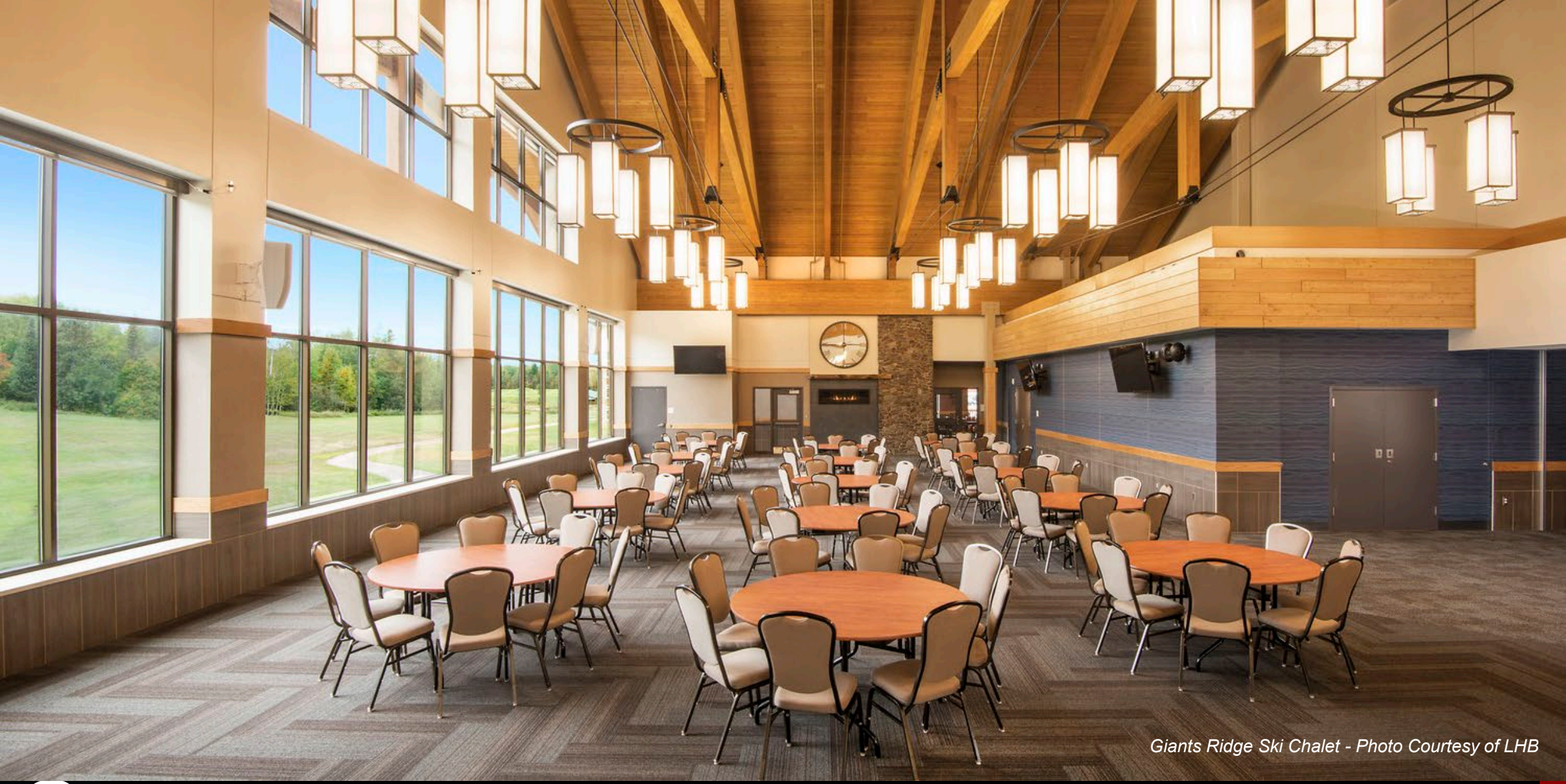
INTENT:

To promote occupant comfort by providing adequate levels of natural and artificial light to maintain sufficient light levels for tasks being performed. Quality lighting can also support cognitive function, mental health, and social interaction while being aesthetically pleasing and complementing the design of the space.

Fergus Falls Public Library - Source: Anthony Gilbert © Gaffer Photography



VALUE OF DAYLIGHT – CIRCADIAN RHYTHMS



Giants Ridge Ski Chalet - Photo Courtesy of LHB

VALUE OF DAYLIGHT – BIOPHILIA

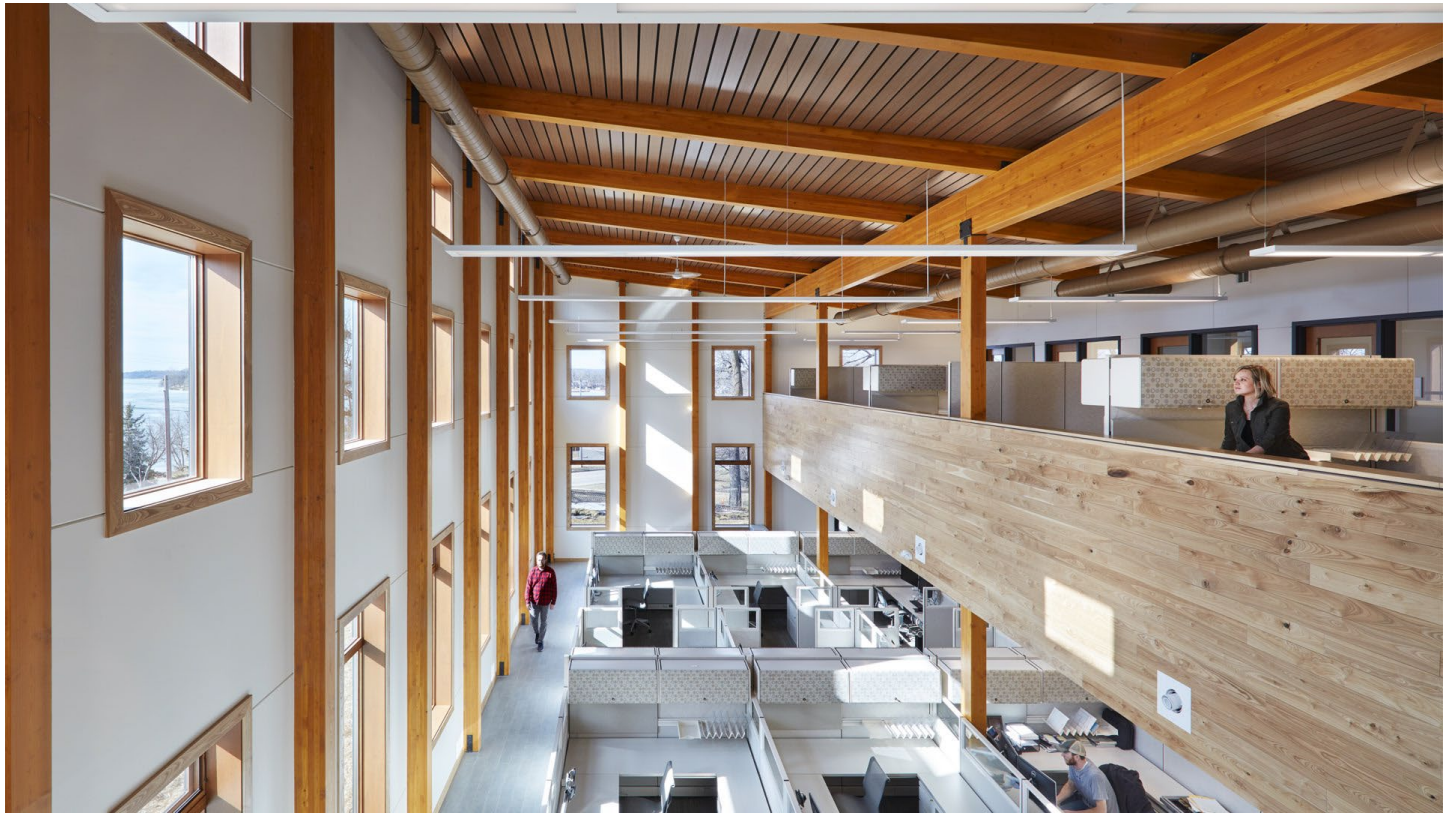
St. David's Center - Photo Courtesy of St. David's Center

VALUE OF DAYLIGHT – ENERGY SAVINGS/RESILIENCE

GUIDELINE I.5C: DAYLIGHTING

APPLICABILITY:

Guideline I.5C applies to New Construction projects and Major Renovation projects that include replacement or construction of relevant systems and assemblies.



DNR Area Office, Glenwood - Source: Kraus Anderson

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REGULARLY OCCUPIED SPACE

Any space that is occupied by one or more persons for more than one hour during the days the building is in use.

This includes spaces which may be irregularly occupied but, when occupied, a typical occupant would spend more than one continual hour in the space.

Regularly Occupied Floor Area: the total floor area within regularly occupied spaces, as defined above.

Hennepin County Medical Examiner's Office
Image credit: Cory Gaffer. Image copyright: LEO A DALY

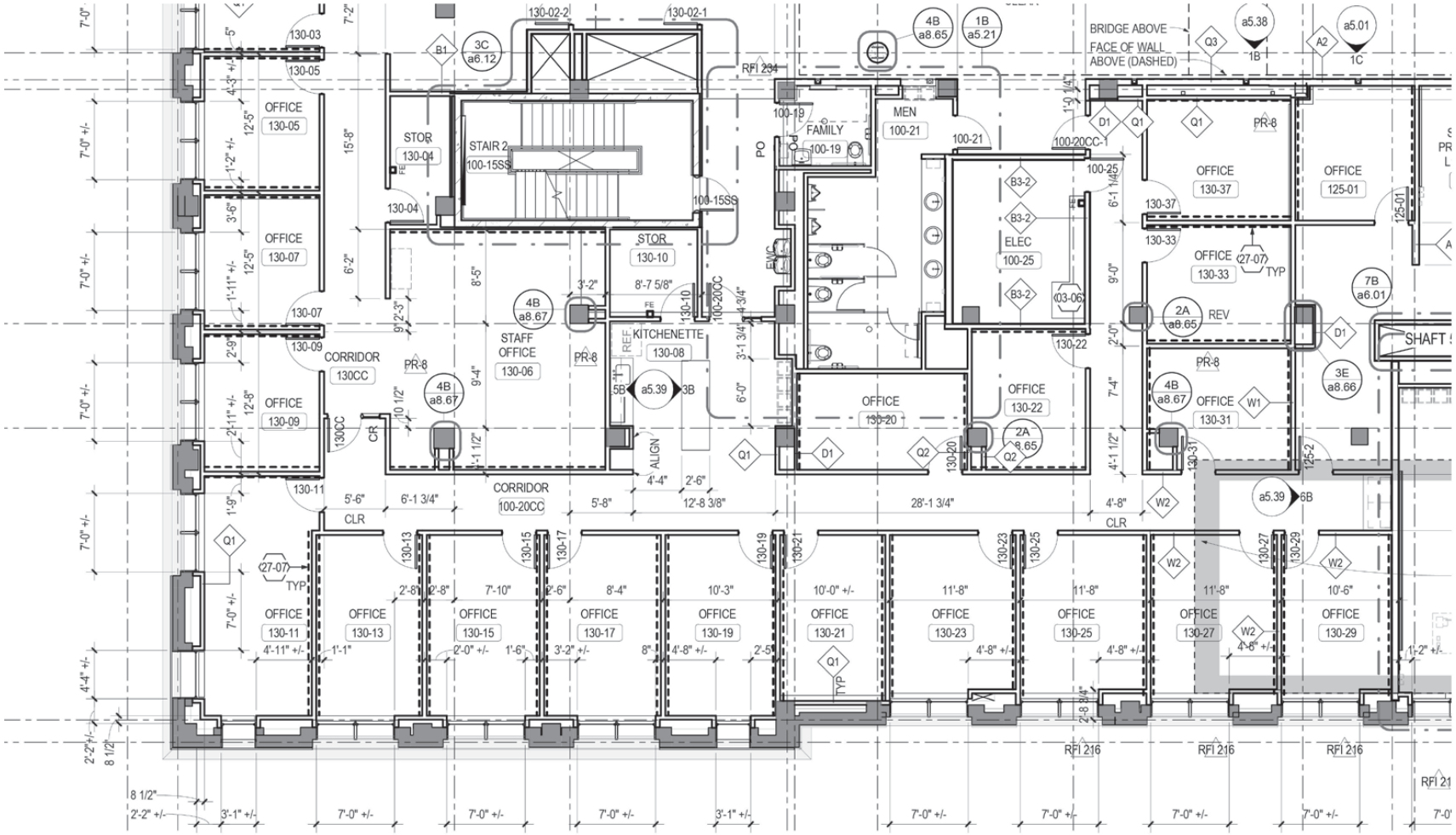
REGULARLY OCCUPIED SPACE - EXCLUSIONS

- Spaces with uses that only require minimal lighting and in which the primary activity intended for the space would be harmed by daylight (such as a theater).

- Spaces that do not meet the minimum occupancy outlined previously during daylight hours.

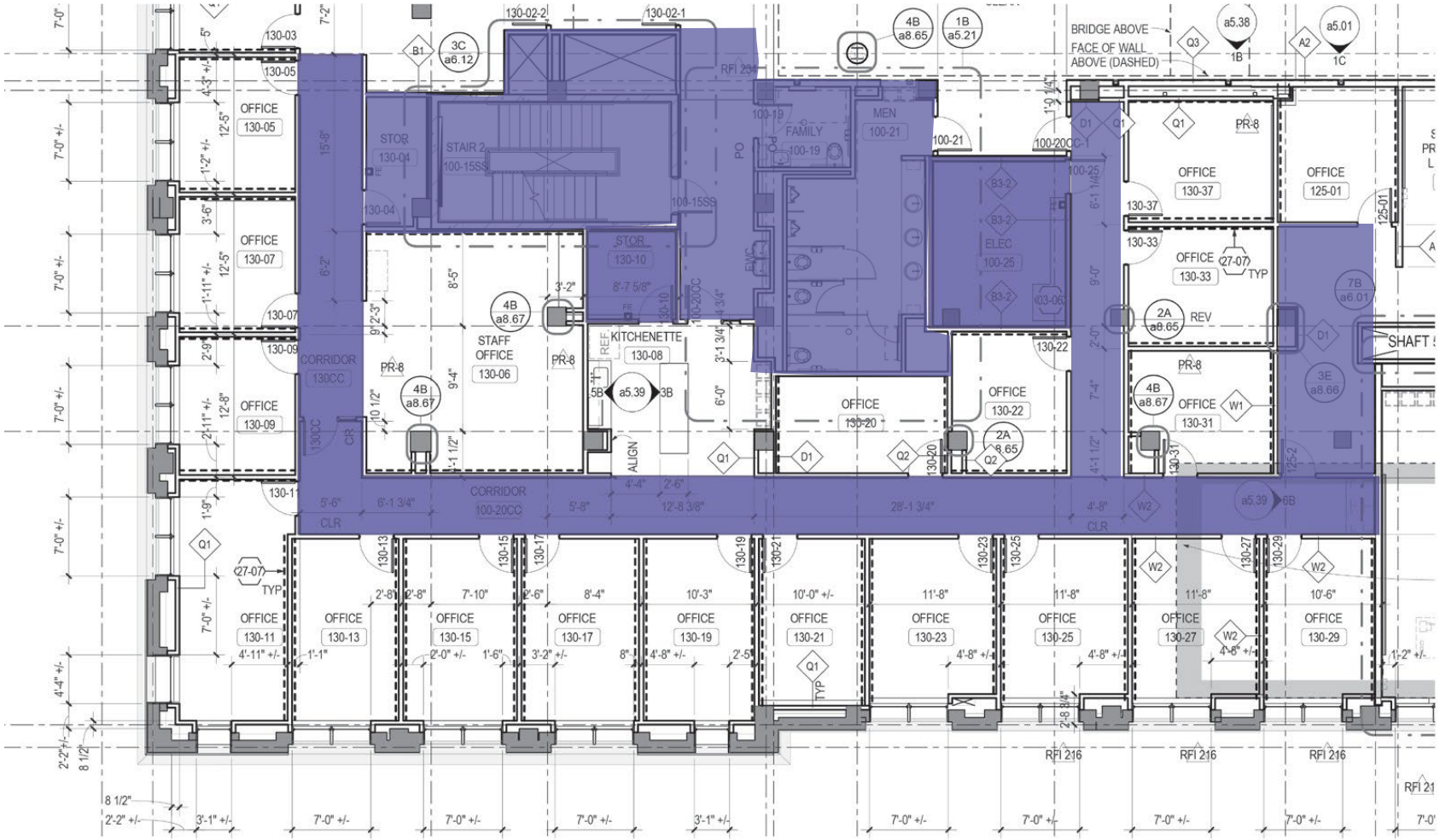
Chatfield Center for the Arts - Source: LHB

REGULARLY OCCUPIED SPACE - EXAMPLE



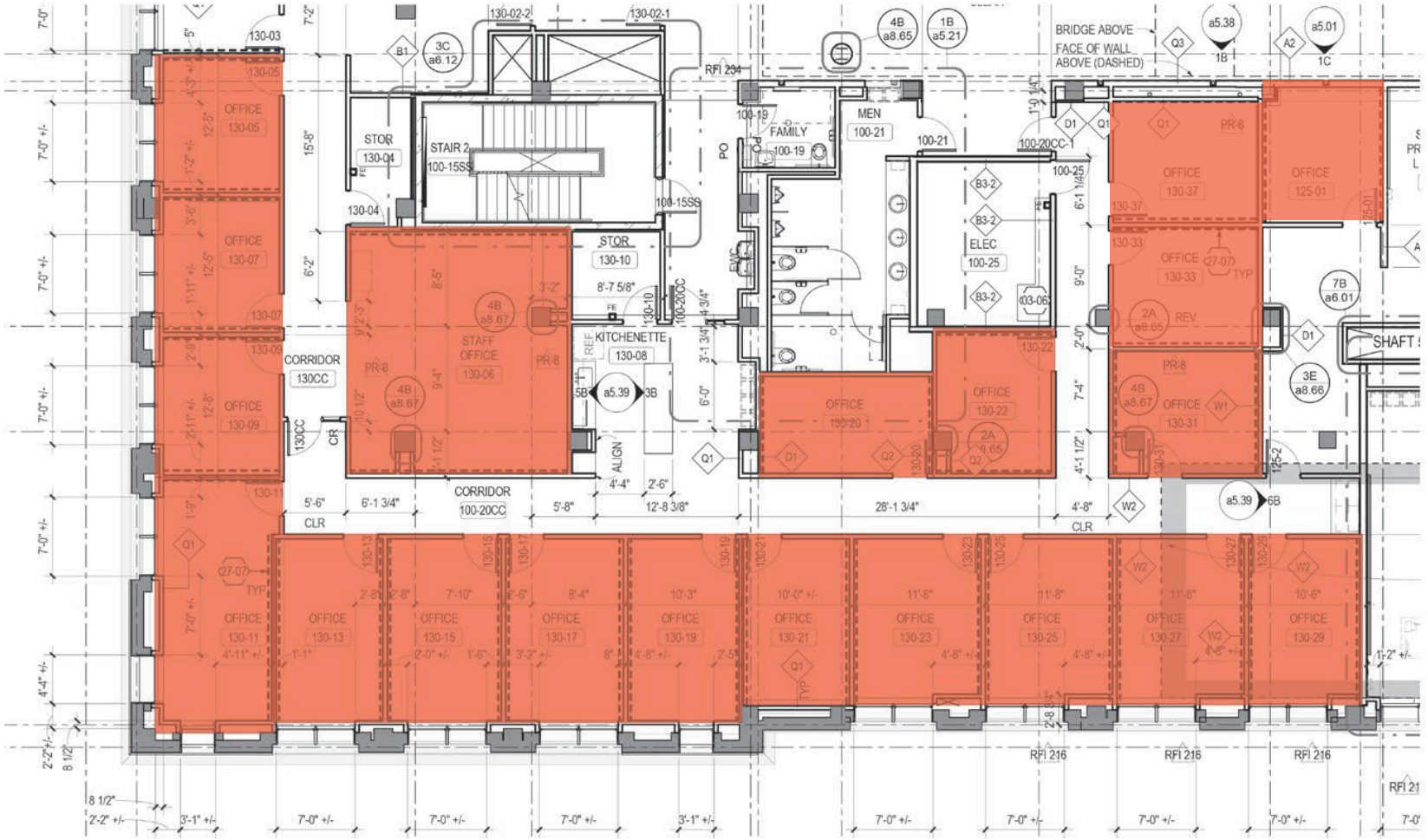
Can be based on plans or program space lists depending on project phase and process

REGULARLY OCCUPIED SPACE - EXAMPLE



Exclude clearly not ‘regularly occupied’ spaces – corridors, inactive storage, mechanical rooms, etc.

REGULARLY OCCUPIED SPACE - EXAMPLE

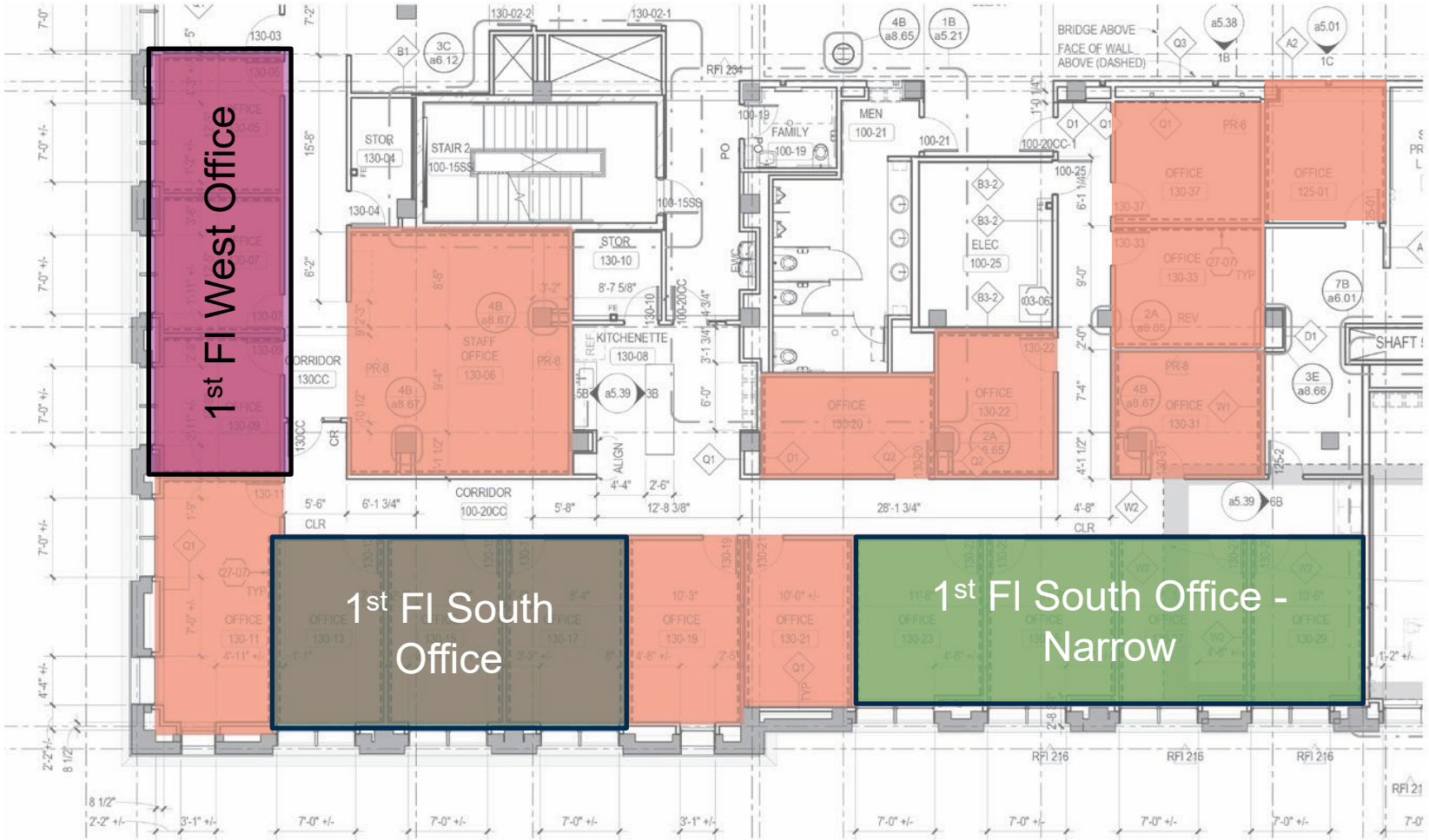


Identify clearly regularly occupied spaces – offices, classrooms, etc.

Group similar size and location rooms

Note different conditions related to daylight e.g. fully interior rooms vs. perimeter rooms

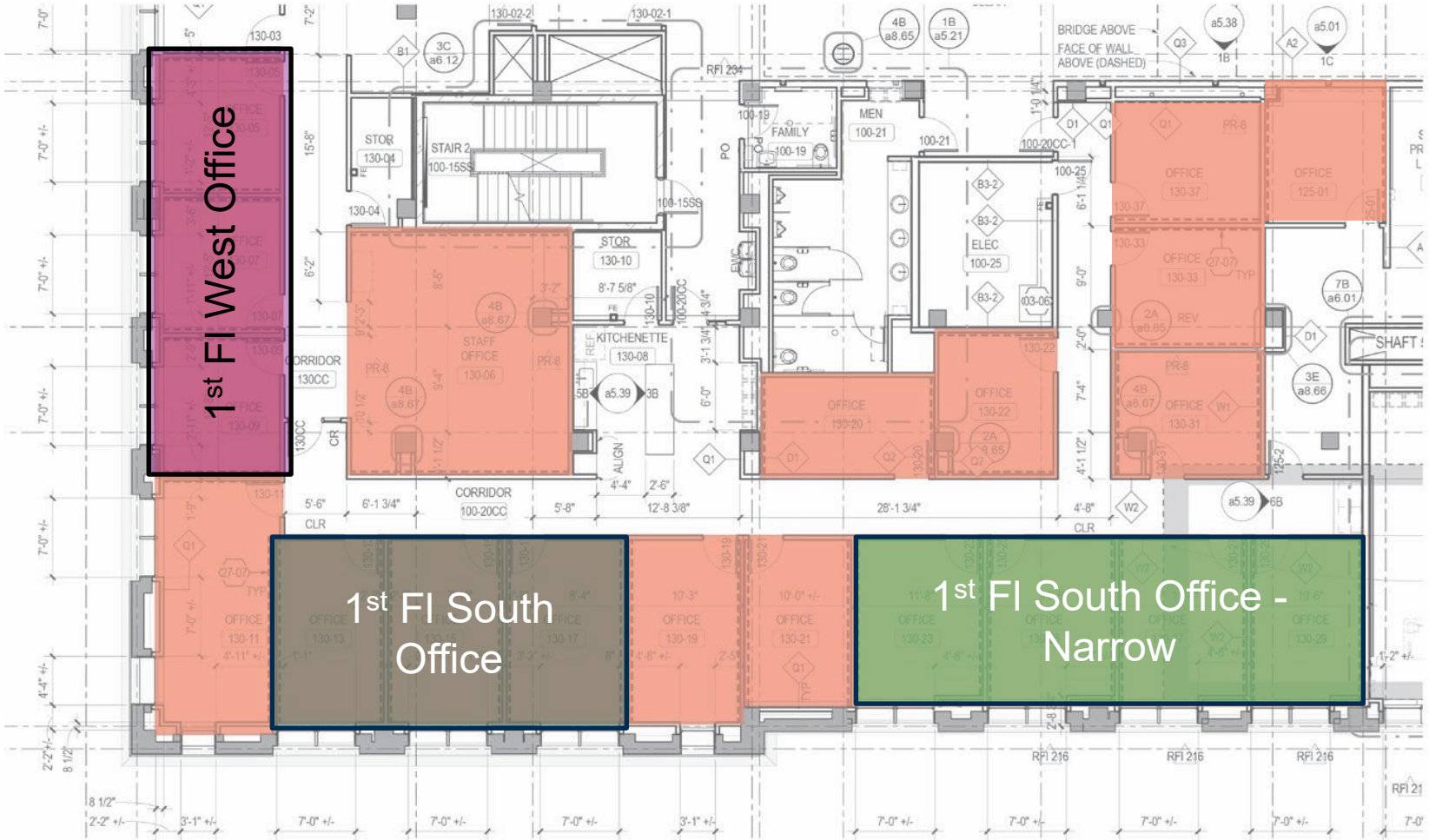
REPRESENTATIVE SPACES



Representative Spaces: For projects containing spaces that are significantly similar in **size, window to wall ratio, window to floor area ratio, and orientation**, a representative space may be used in the B3 Daylighting Spreadsheet.

Entries should include the area totals for the entire group of spaces represented and list the included rooms by number and/or name. For these spaces, the simulated daylight utilization of a single room can be applied to the entire represented area.

REPRESENTATIVE SPACES

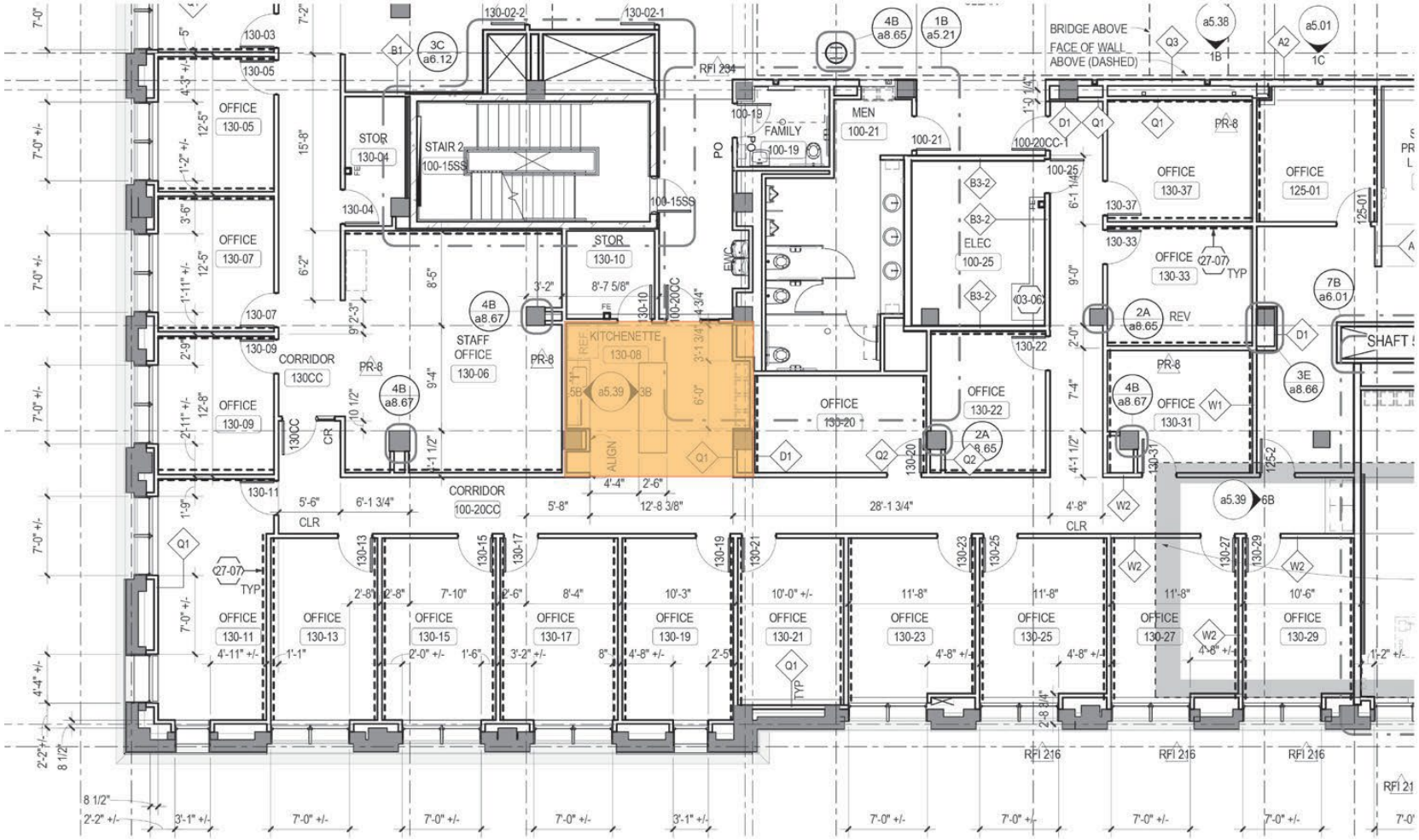


1st Floor West Office
Rooms 130-05, 07, 09
300ft2

1st Floor South Office
Rooms 130-13, 15, 17
330 ft2

1st Floor South Office – Narrow
Rooms 130-23, 25, 27, 29
400 ft2

REGULARLY OCCUPIED SPACE - EXAMPLE



Some spaces may be ambiguous – break rooms, reception areas.

Clarify programming when possible to determine if space will qualify as ‘regularly occupied.’

OUTLINE

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GUIDELINE I.5C

DAYLIGHTING – GLARE CONTROL

1. On facades facing within 45 degrees of east, south or west: Provide glare control devices with manual operation (or automatic with manual override) for 90% of all regularly occupied spaces.

Glare control devices include interior window blinds, shades, curtains, exterior moveable louvers, screens, and awnings

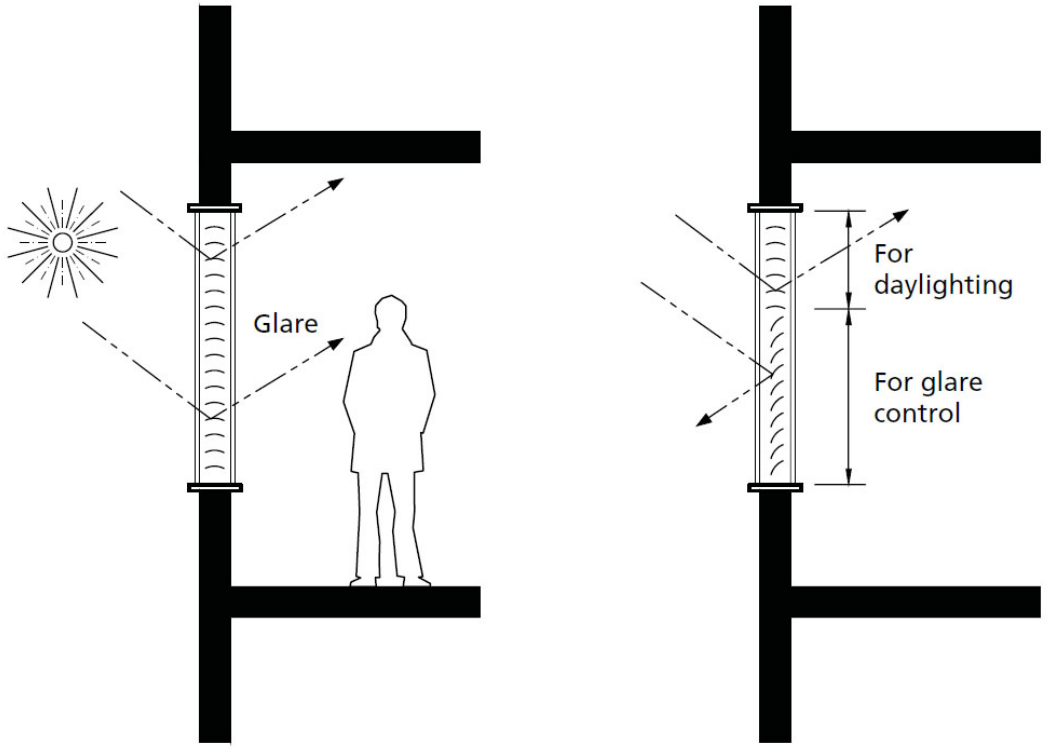

Figure 13.11l To prevent dirt accumulation, venetian blinds can be sandwiched between two layers of glass, but they are most effective if placed on the exterior of the glazing. For daylighting purposes, they should come in pairs: the top one for daylighting and the bottom one for glare control. They are especially appropriate on east and west facades because they can block the low sun.

Source: Heating, Cooling, Lighting: Sustainable Design Methods for Architects, Lechner, 2008

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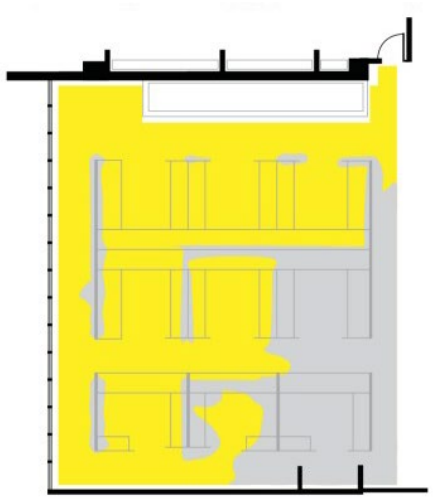


Source: Architect Magazine

GUIDELINE I.5C

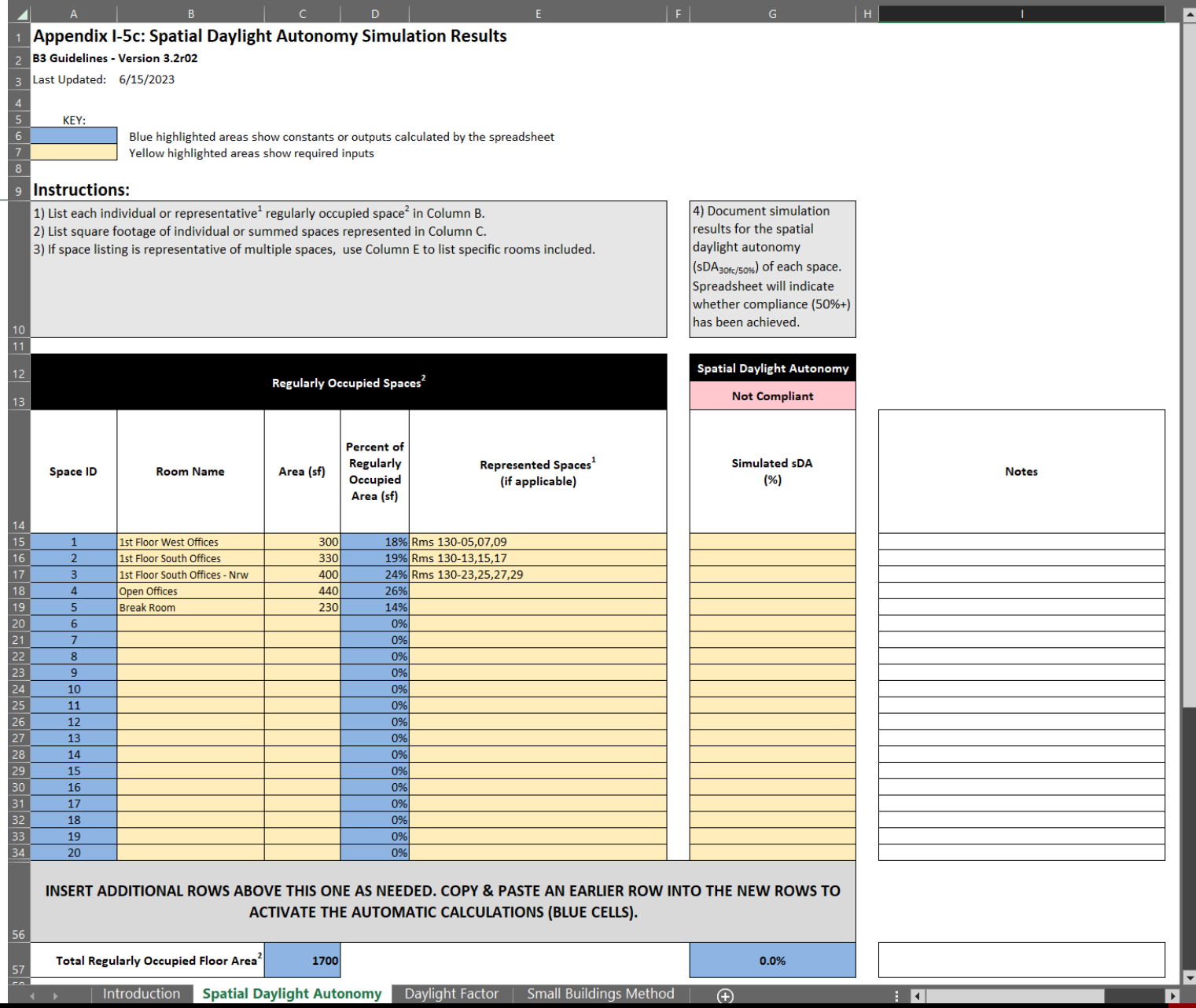
2. DEMONSTRATE DAYLIGHT UTILIZATION WITH ONE OF THE FOLLOWING:

i. Spatial Daylight Autonomy (sDA30fc/50%) in at least 50% of Regularly Occupied Floor Area. I.e., at least 50% of the Regularly Occupied Floor Area must achieve a minimum of 30fc for at least 50% of operating hours per year.

Spatial Daylight Autonomy (sDA) examines whether a space receives enough daylight (30 footcandles) during standard operating hours (8 a.m. to 6 p.m.) on an annual basis using hourly illuminance grids on the horizontal work plane.

B3 I.5C WORKSHEET

- Enter regularly occupied space names and floor areas in Spatial Daylight Autonomy tab.



Appendix I-5c: Spatial Daylight Autonomy Simulation Results

B3 Guidelines - Version 3.2r02

Last Updated: 6/15/2023

KEY:

Blue highlighted areas show constants or outputs calculated by the spreadsheet

Yellow highlighted areas show required inputs

Instructions:

1) List each individual or representative[1] regularly occupied space[2] in Column B.
2) List square footage of individual or summed spaces represented in Column C.
3) If space listing is representative of multiple spaces, use Column E to list specific rooms included.

4) Document simulation results for the spatial daylight autonomy ($sDA_{300lx/50\%}$) of each space. Spreadsheet will indicate whether compliance (50%+) has been achieved.

Regularly Occupied Spaces[2]					Spatial Daylight Autonomy	
					Not Compliant	
Space ID	Room Name	Area (sf)	Percent of Regularly Occupied Area (sf)	Represented Spaces[1] (if applicable)	Simulated sDA (%)	Notes
1	1st Floor West Offices	300	18%	Rms 130-05,07,09		
2	1st Floor South Offices	330	19%	Rms 130-13,15,17		
3	1st Floor South Offices - Nrw	400	24%	Rms 130-23,25,27,29		
4	Open Offices	440	26%			
5	Break Room	230	14%			
6			0%			
7			0%			
8			0%			
9			0%			
10			0%			
11			0%			
12			0%			
13			0%			
14			0%			
15			0%			
16			0%			
17			0%			
18			0%			
19			0%			
20			0%			

INSERT ADDITIONAL ROWS ABOVE THIS ONE AS NEEDED. COPY & PASTE AN EARLIER ROW INTO THE NEW ROWS TO ACTIVATE THE AUTOMATIC CALCULATIONS (BLUE CELLS).

Total Regularly Occupied Floor Area[2]	1700		0.0%	

Introduction | Spatial Daylight Autonomy | Daylight Factor | Small Buildings Method

B3 I.5C WORKSHEET

- Perform daylight simulations in preferred software and enter results

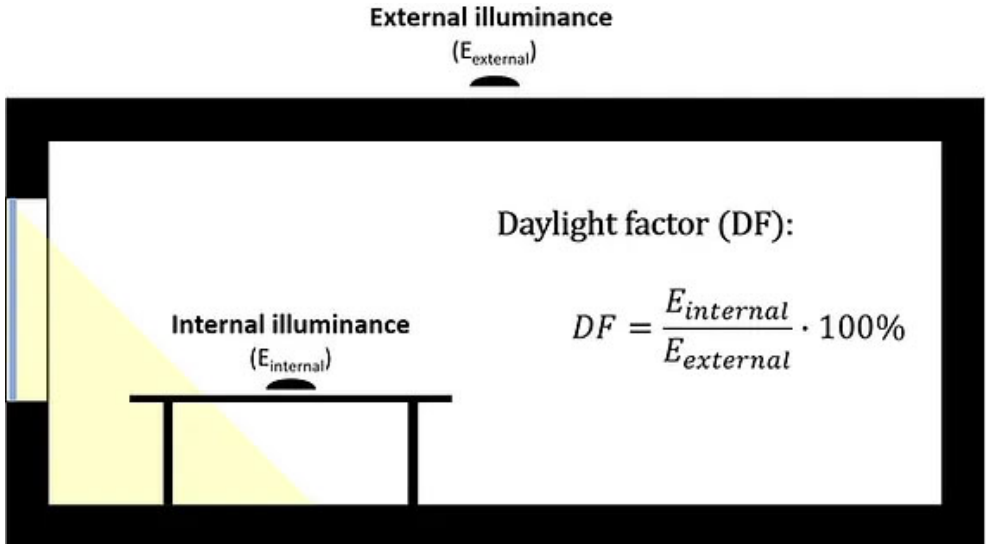
- Spreadsheet will calculate weighted value of results and determine compliance. Compliance is determined based on area weighted results, not by each space meeting the requirement.

Regularly Occupied Spaces[2]					Spatial Daylight Autonomy
					Compliant
Space ID	Room Name	Area (sf)	Percent of Regularly Occupied Area (sf)	Represented Spaces[1] (if applicable)	Simulated sDA (%)
1	1st Floor West Offices	300	18%	Rms 130-05,07,09	44%
2	1st Floor South Offices	330	19%	Rms 130-13,15,17	70%
3	1st Floor South Offices - Nrw	400	24%	Rms 130-23,25,27,29	70%
4	Open Offices	440	26%		40%
5	Break Room	230	14%		45%
Total Regularly Occupied Floor Area[2]		**1700**			**54.3%**

GUIDELINE I.5C

2. DEMONSTRATE DAYLIGHT UTILIZATION WITH ONE OF THE FOLLOWING:

ii. Daylight Factor (DF) of at least 1.0% in at least 50% of Regularly Occupied Floor Area. **Evaluation is performed using the percentage of Regularly Occupied Floor Area meeting the 1% threshold—not with a simple average daylight factor.** Compliance is evaluated by using a percentage of floor area, not as a percentage of the number of spaces.



Source: IEN Consultants

Daylight Factor (DF) is the ratio of the light level inside a structure to the light level outside the structure.

B3 I.5C WORKSHEET

- Enter regularly occupied space names and floor areas in Daylight Factor tab.

Regularly Occupied Spaces[2]					Daylight Factor
					Not Compliant
Space ID	Room Name	Area (sf)	Percent of Regularly Occupied Area (sf)	Represented Spaces[1] (if applicable)	% Floor Area DF ≥ 1.0%
1	1st Floor West Offices	300	18%	Rms 130-05,07,09	
2	1st Floor South Offices	330	19%	Rms 130-13,15,17	
3	1st Floor South Offices - Nrw	400	24%	Rms 130-23,25,27,29	
4	Open Offices	440	26%		
5	Break Room	230	14%		
Total Regularly Occupied Floor Area[2]		**1700**			**0.0%**

B3 I.5C WORKSHEET

- Perform daylight simulations in preferred software and enter results.
- Some software outputs require manual calculation of floor area with a Daylight Factor of 1 or higher, refer to the simulation software summary table for more information.
- Spreadsheet will calculate weighted value of results and determine compliance. Compliance is determined based on area weighted results, not by each space meeting the requirement.

Daylight Factor
Compliant
% Floor Area DF ≥ 1.0%
48%
68%
73%
41%
32%
53.8%

GUIDELINE I.5C

2. DEMONSTRATE DAYLIGHT UTILIZATION WITH ONE OF THE FOLLOWING:

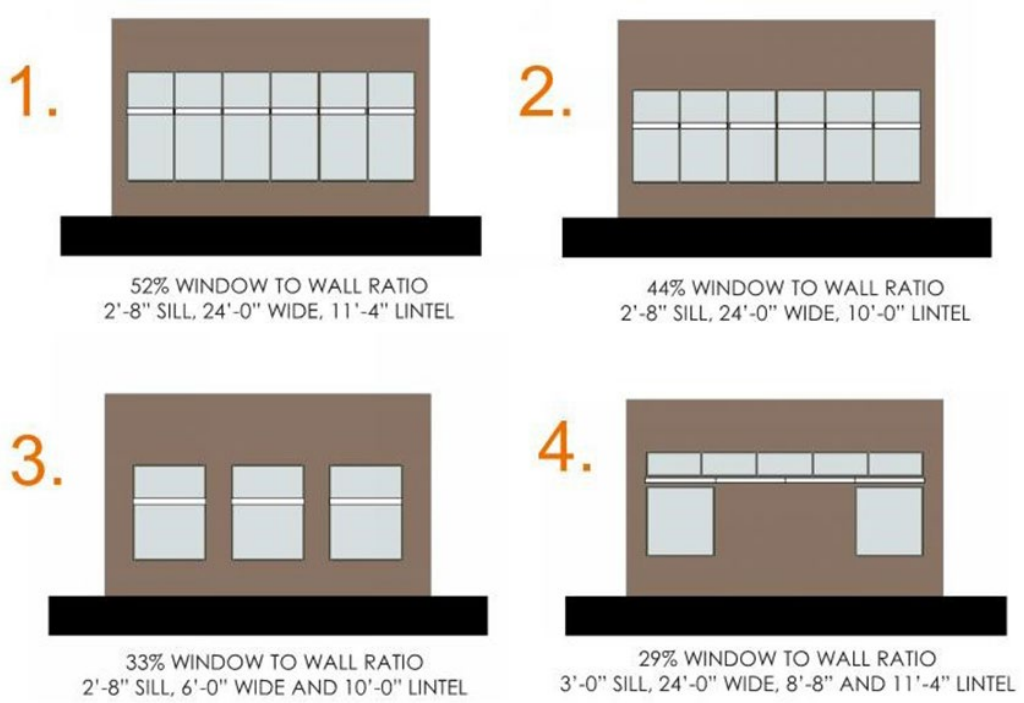
iii. Projects that include less than 20,000 gsf of conditioned space may demonstrate adequate daylight utilization by complying with option i or ii as described above, or by documenting a **window-to-wall area ratio** (WWR) of the portion of exterior walls bounding regularly occupied spaces of **at least 35%,** and a **minimum visible transmittance (VT) of 0.65 for all exterior glazing** in regularly occupied spaces.

GUIDELINE I.5C

WINDOW TO WALL AREA RATIO

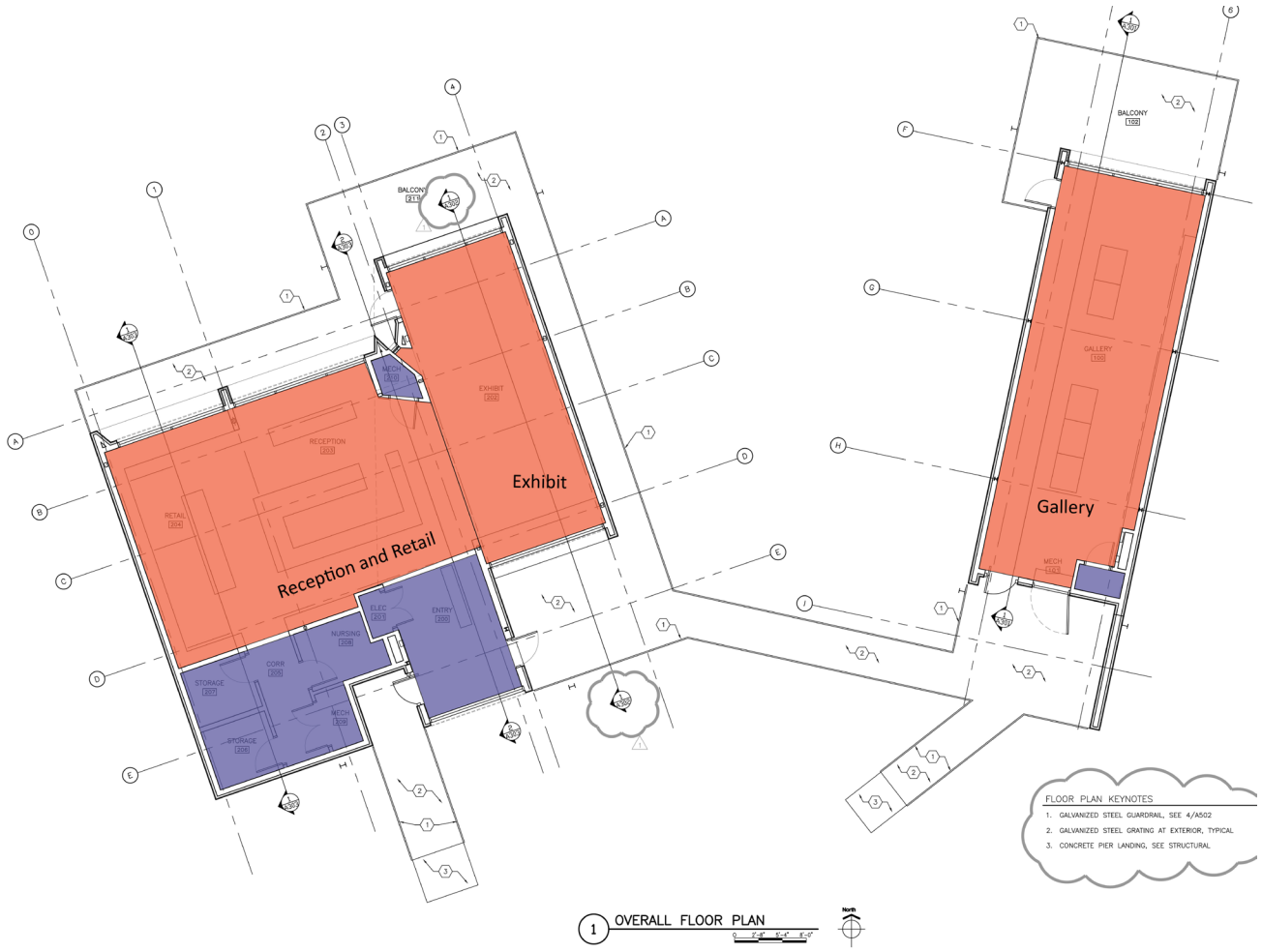
The fraction of wall area that is covered by fenestration, represented as a percentage. “Wall area” refers to the interior finished area of the exterior wall(s) in the Regularly Occupied Space(s). “Window area” refers to the area of the entire window unit(s), including the frame(s).

$$WWR\ \% = \frac{Total\ Glazing\ Area\ of\ ROS\ (ft2)}{Total\ Exterior\ Wall\ Area\ of\ ROS(ft2)} \times 100$$



Source: Stantec

SMALL BUILDINGS - REGULARLY OCCUPIED SPACE



As with larger projects, identify which spaces meet the definition of ‘Regularly Occupied’.

List those spaces, including any spaces without exterior wall area (i.e., fully interior spaces), in the worksheet.

B3 I.5C WORKSHEET

- Enter regularly occupied space names and window area in the Small Buildings tab.
- Window area refers to the entire window unit, including frames.

Regularly Occupied Spaces[2]						Compliance
						Undetermined
Space ID	Room Name	Window Area (sf)	Exterior Wall Area (sf)	Floor Area (sf)	Represented Spaces[1] (if applicable)	Window-to-Wall Area Ratio (WWR) ≥35%
1	Exhibit	200				Undetermined
2	Retail / Reception	215				Undetermined
3	Gallery	190				Undetermined
	Total	605	0	0		Undetermined

B3 I.5C WORKSHEET

- Enter exterior wall area and floor area for each space.
- "*Exterior Wall Area*" refers to the interior finished face area of the exterior wall(s) in the space.
- "*Floor Area*" refers to the interior finished floor area for the space.
- If there are Regularly Occupied Spaces with no exterior wall area, list floor area and "0" for window and wall area.

Regularly Occupied Spaces[2]						Compliance
						Compliant
Space ID	Room Name	Window Area (sf)	Exterior Wall Area (sf)	Floor Area (sf)	Represented Spaces[1] (if applicable)	Window-to-Wall Area Ratio (WWR) ≥35%
1	Exhibit	200	252	480		79%
2	Retail / Reception	215	306	810		70%
3	Gallery	190	372	700		51%
	Total	605	930	1990		65.1%

B3 I.5C WORKSHEET

- As window, wall, floor areas are entered, the worksheet calculates the overall WWR and will indicate compliance status.
- Compliance is determined based on project totals, not by each space meeting the requirement

Regularly Occupied Spaces[2]						Compliance
						Compliant
Space ID	Room Name	Window Area (sf)	Exterior Wall Area (sf)	Floor Area (sf)	Represented Spaces[1] (if applicable)	Window-to-Wall Area Ratio (WWR) ≥35%
1	Exhibit	200	252	480		79%
2	Retail / Reception	215	306	810		70%
3	Gallery	190	372	700		51%
	Total	605	930	1990		65.1%

GUIDELINE I.5C

SIMULATION SOFTWARE SUMMARY

Software Name	Spatial Daylight Autonomy Analysis	Daylight Factor Analysis	Surface Reflectance Settings
Sefaira for Sketchup or Revit	Yes	Yes – manual calculation of floor area above threshold	Ceilings – 80% Walls – 50% Floors – 20%
Insight for Revit	Yes	Yes – automatically reports floor area above threshold	Adjustable – set in Revit Model
Lightstanza	Yes	Yes – automatically reports floor area above threshold	Adjustable – set in web application
Andrew Marsh Tools – Dynamic Daylighting	Yes, with upload of weather file	Yes – automatically reports floor area above threshold	Adjustable – set in web application
Cove Tool	Yes	No	Ceiling/Roof - 70% Interior Walls - 50% Floors - 20%

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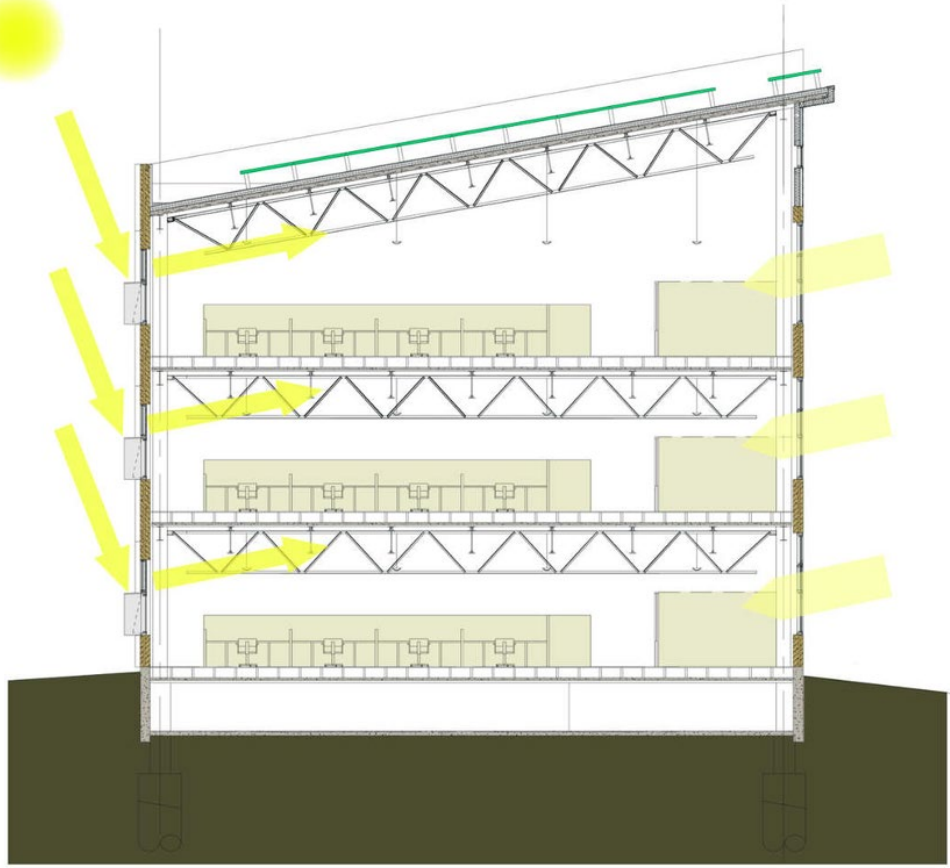
DAYLIGHT DESIGN – RULES OF THUMB

- Orient building so primary axis runs east-west, resulting in majority of floor area either south or north facing



Daylight enters the upper portions of the south facing windows and is reflected up to the ceiling and deep into the space with a light reflecting LightLouver. Indirect ambient daylight enters from the north facing windows. 100% of the workspaces are daylit.

Source: RNL Design

DAYLIGHT DESIGN – RULES OF THUMB

- Narrow floor plates
- High ceilings
- Consider overhead openings

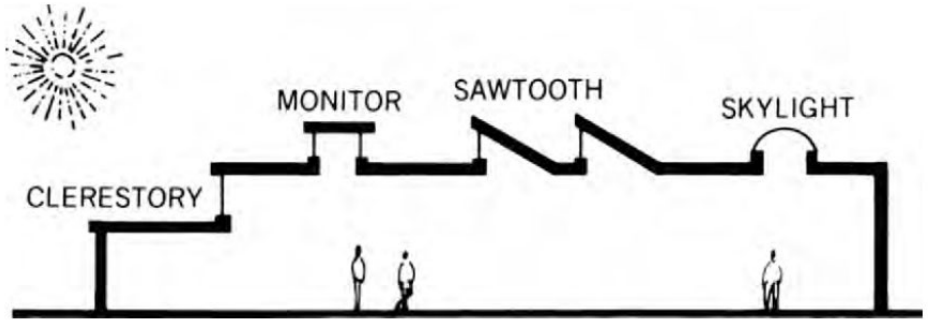


Figure 13.9d The various possibilities for overhead openings for daylighting are shown.

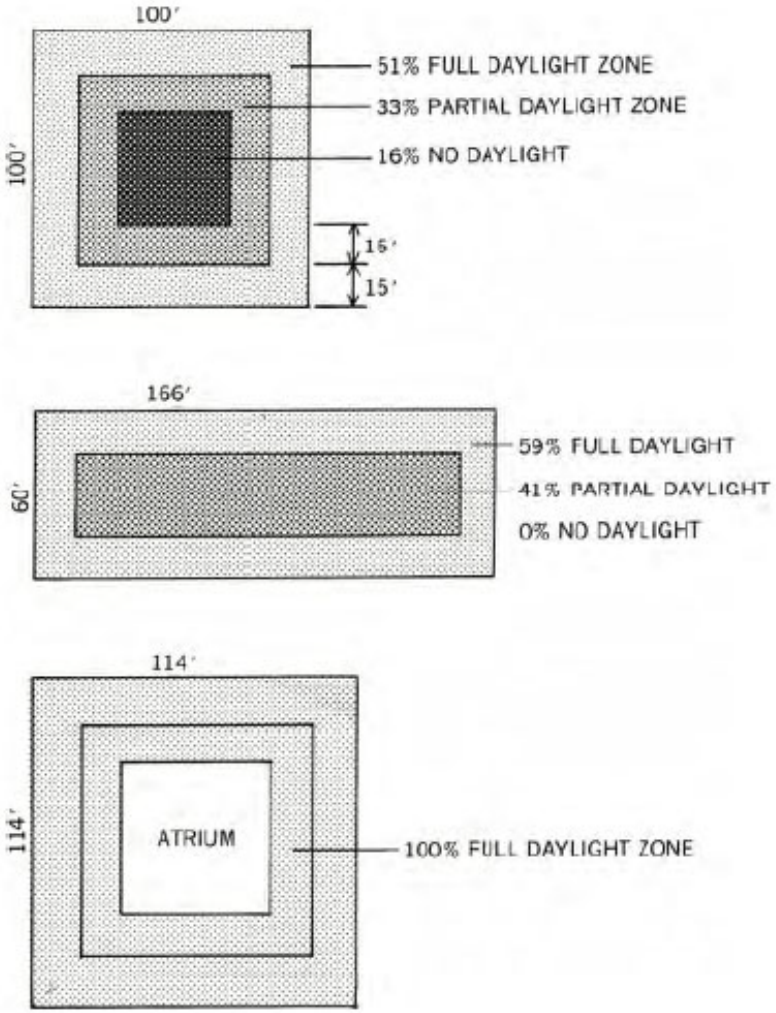


Figure 13.9e These alternative plans of a multistory office building illustrate the effect of massing on the availability of daylight.

Source: Heating, Cooling, Lighting: Sustainable Design Methods for Architects, Lechner, 2008

DAYLIGHT DESIGN – RULES OF THUMB

- Open sections – remove or lower interior walls
- Use high reflectance materials

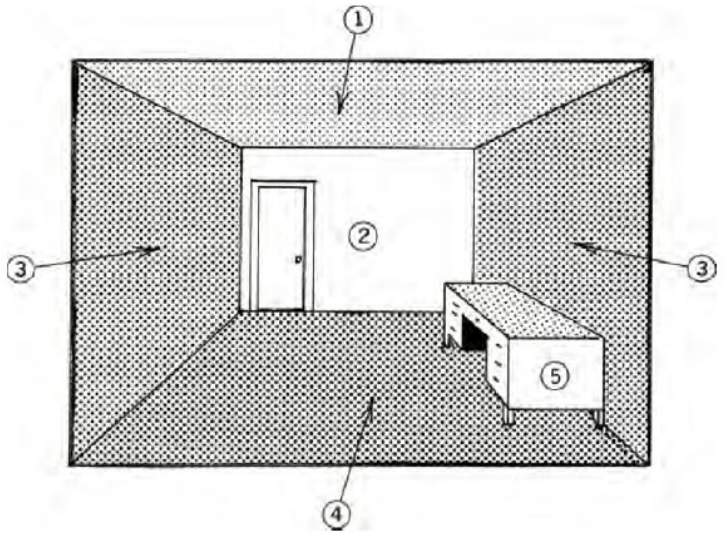
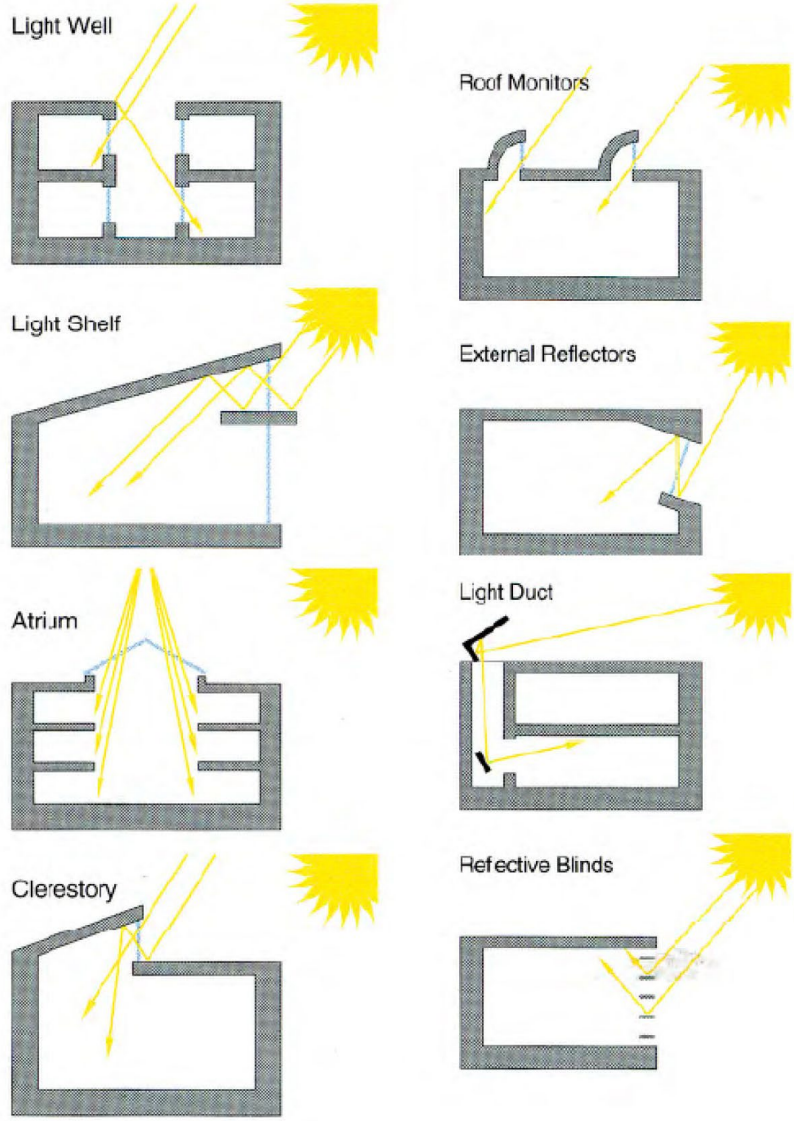


Figure 13.9i For good distribution and penetration of light, the order of importance for high reflectance finishes is shown (e.g., surface 1 should have the highest reflectance factor).

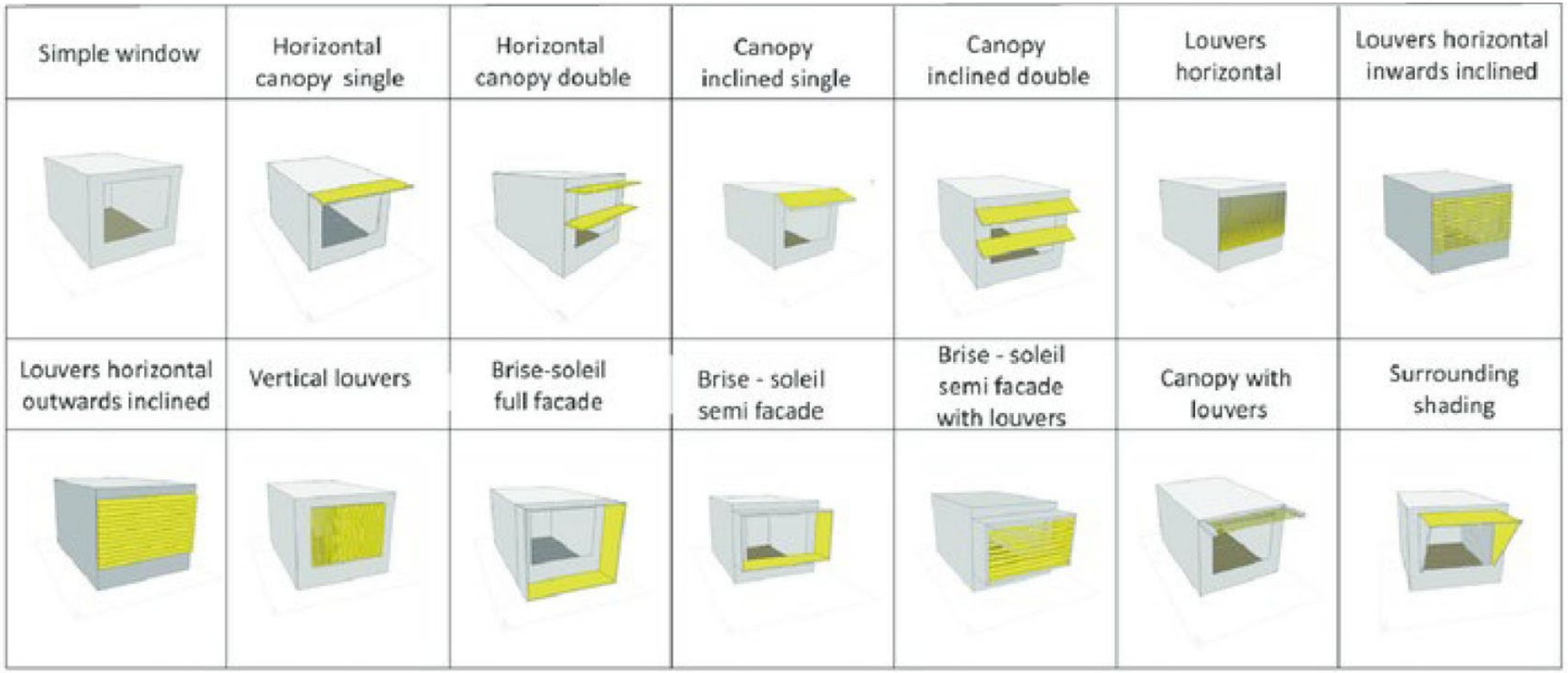
Source: Heating, Cooling, Lighting: Sustainable Design Methods for Architects, Lechner, 2008



Source: Qais Tabib

DAYLIGHT DESIGN – CONTROLLING DAYLIGHT

- Control glare – excessive light on task surfaces can make spaces uncomfortable to unusable



Source: Maria Mandalaki, Research Gate

DAYLIGHT DESIGN – CONTROLLING DAYLIGHT

- Control solar heat gain – desirable in winter, undesirable in summer
- Heat and light are easier to block than to remove – utilize external shading devices when possible

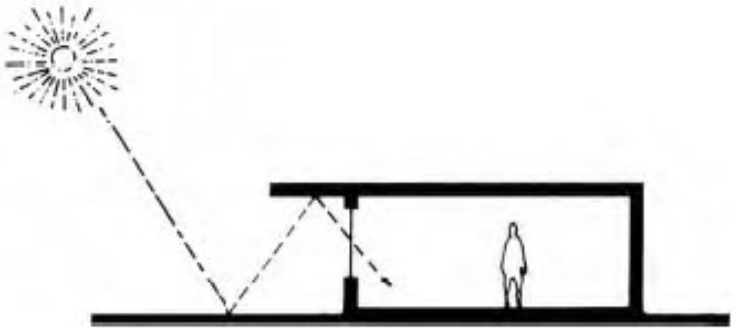


Figure 13.10j Large, horizontal overhangs block too much light unless both the ground and the underside of the overhang have high reflectance values.

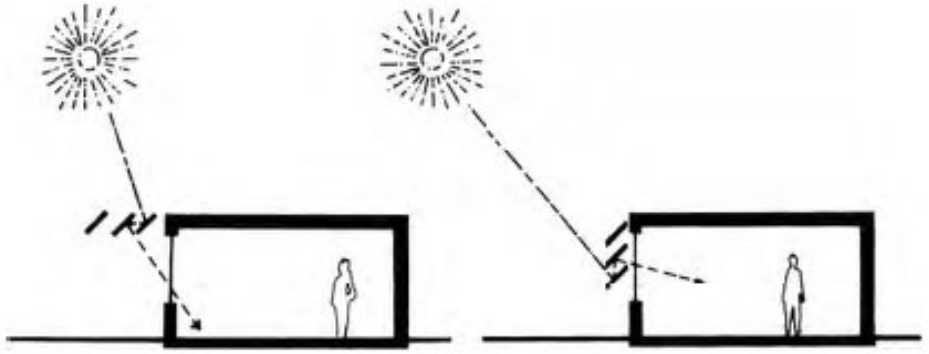


Figure 13.10k Light-colored louvers block direct sunlight but allow some diffused light to enter the windows.

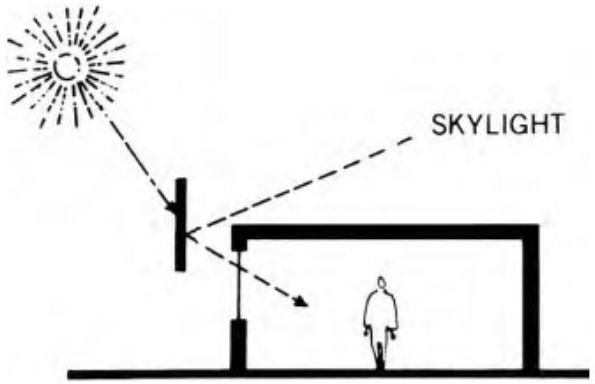


Figure 13.10l A vertical panel can block direct sunlight while it reflects diffuse skylight.

Source: Heating, Cooling, Lighting: Sustainable Design Methods for Architects, Lechner, 2008

DAYLIGHT DESIGN – CONTROLLING DAYLIGHT

- Controls for the glare management
- Test strategies with daylight and energy modeling

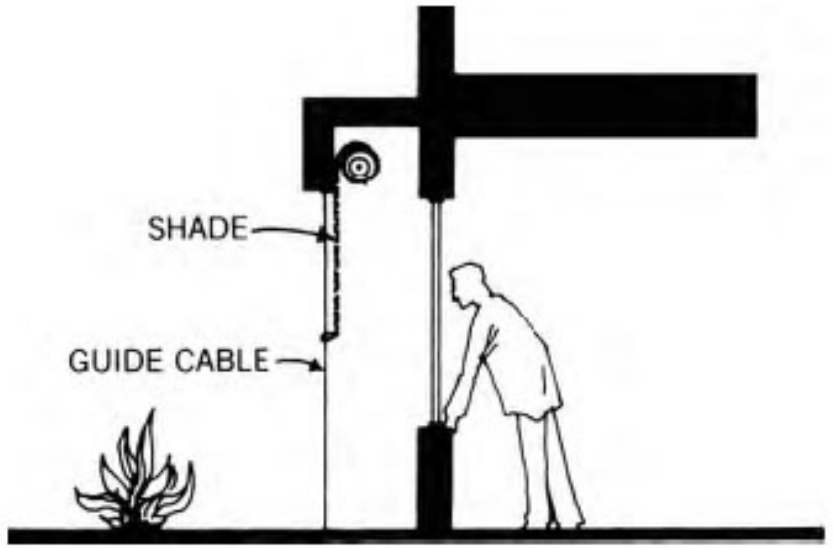


Figure 13.10m On the east and west facades, the Bateson Building in Sacramento, California, uses exterior translucent roller shades that automatically respond to sun and wind conditions.

Source: Heating, Cooling, Lighting: Sustainable Design Methods for Architects, Lechner, 2008

THANK YOU FOR WATCHING!

Additional questions or comments can be sent to the B3 Guidelines Administrators at guidelines@b3mn.com