Room-side Low-e Coating: As Good As It Sounds?

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Architect

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Designer

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PAYETTE

LEARNING OBJECTIVES

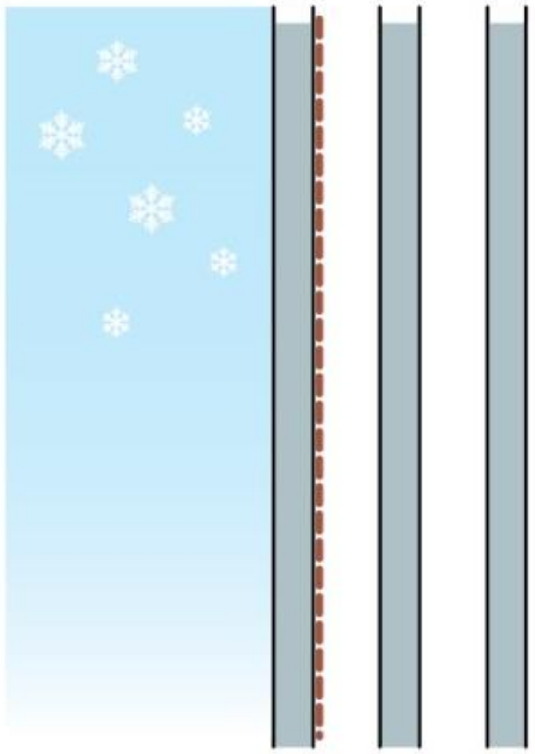
1. Upon completion, participants will be able to identify the modes of heat transfer and how each has the ability to affect thermal comfort.

2. Upon completion, participants will be able to identify the factors that influence thermal comfort as defined by ASHRAE 55.

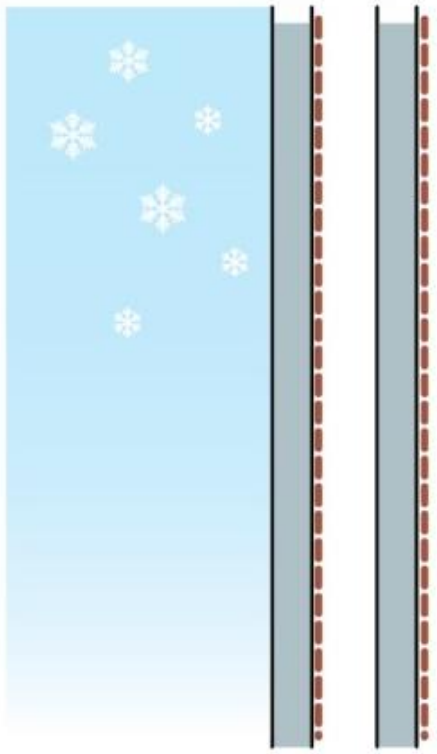
3. Upon completion, participants will understand how emissivity affects the radiant heat transfer process, the glazing U-value, and the impact on glazing unit technology.

4. Upon completion, participants will be able to evaluate different types of glazing units in terms of the risk of radiant discomfort and/or downdraft.

ROOM-SIDE LOW-E COATING



Triple-Glazed IGU



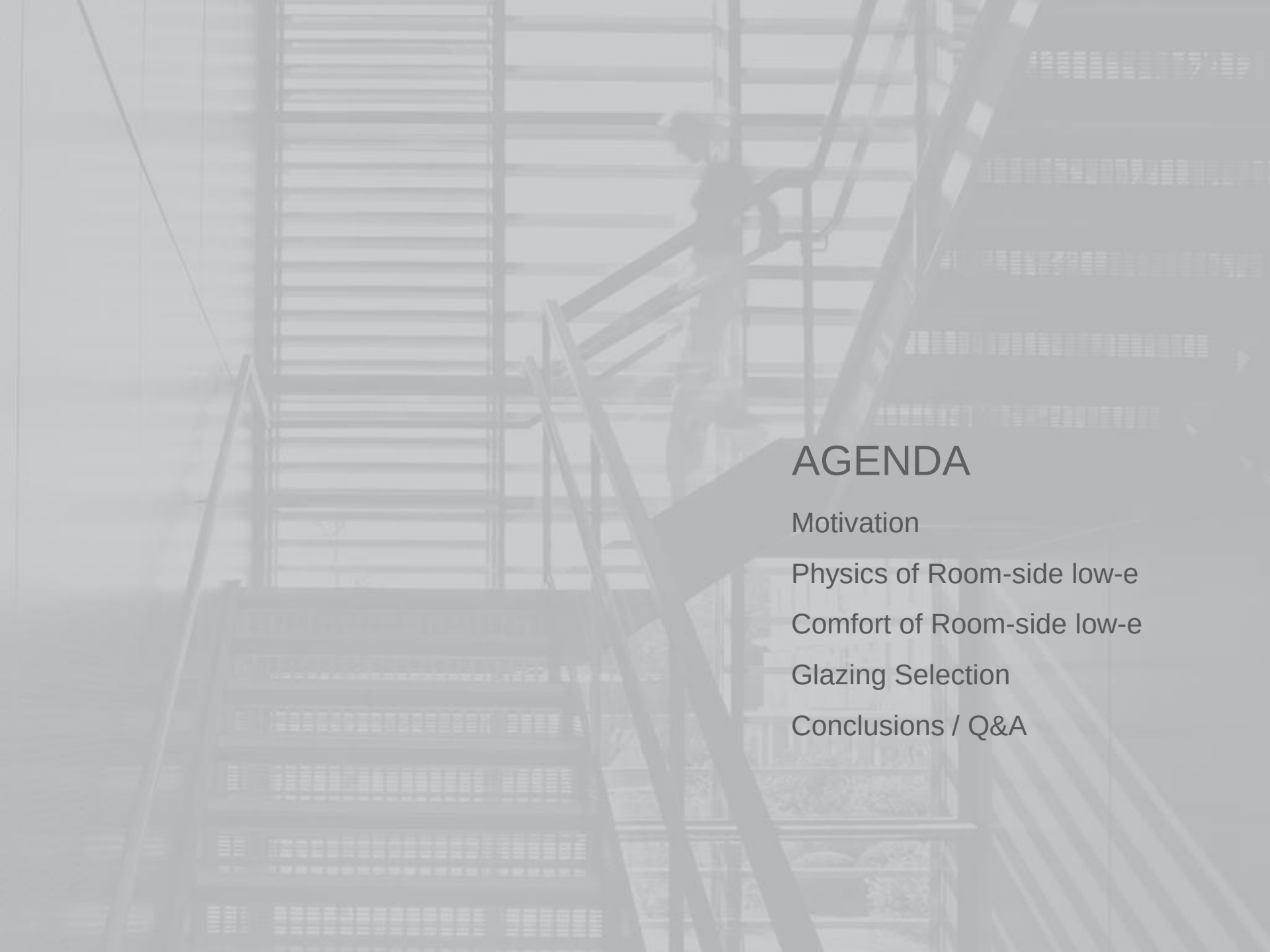
Double-Glazed IGU
with Room-side low-e

ROOM-SIDE LOW-E

- *Room-side*, *4th surface*, *Indoor surface* low-e
- ε ~ 0.2 (compared to ε ~ 0.05 of cavity coatings)
- Scratch-resistant clear coating
- Lighter, cheaper
- Improved radiant occupant comfort

		Transmittance		Reflectance			Winter U-value ½" Gap	
	Low-e surface	Visible	Solar	Visible in	Visible out	SHGC	Argon	Air
Double pane	#2	62%	23%	12%	11%	0.23	0.24	0.29
	#2, **#4**	60%	22%	13%	12%	0.22	0.20	0.23
Triple pane	#2	51%	19%	14%	14%	0.21	0.18	0.21
	#2, #4	29%	10%	15%	16%	0.16	0.12	0.16
	#2, **#6**	45%	17%	20%	16%	0.20	0.15	0.18
	#2, #4, **#6**	29%	9%	16%	16%	0.15	0.11	0.13

ROOM-SIDE LOW-E: AS GOOD AS IT SOUNDS?



AGENDA

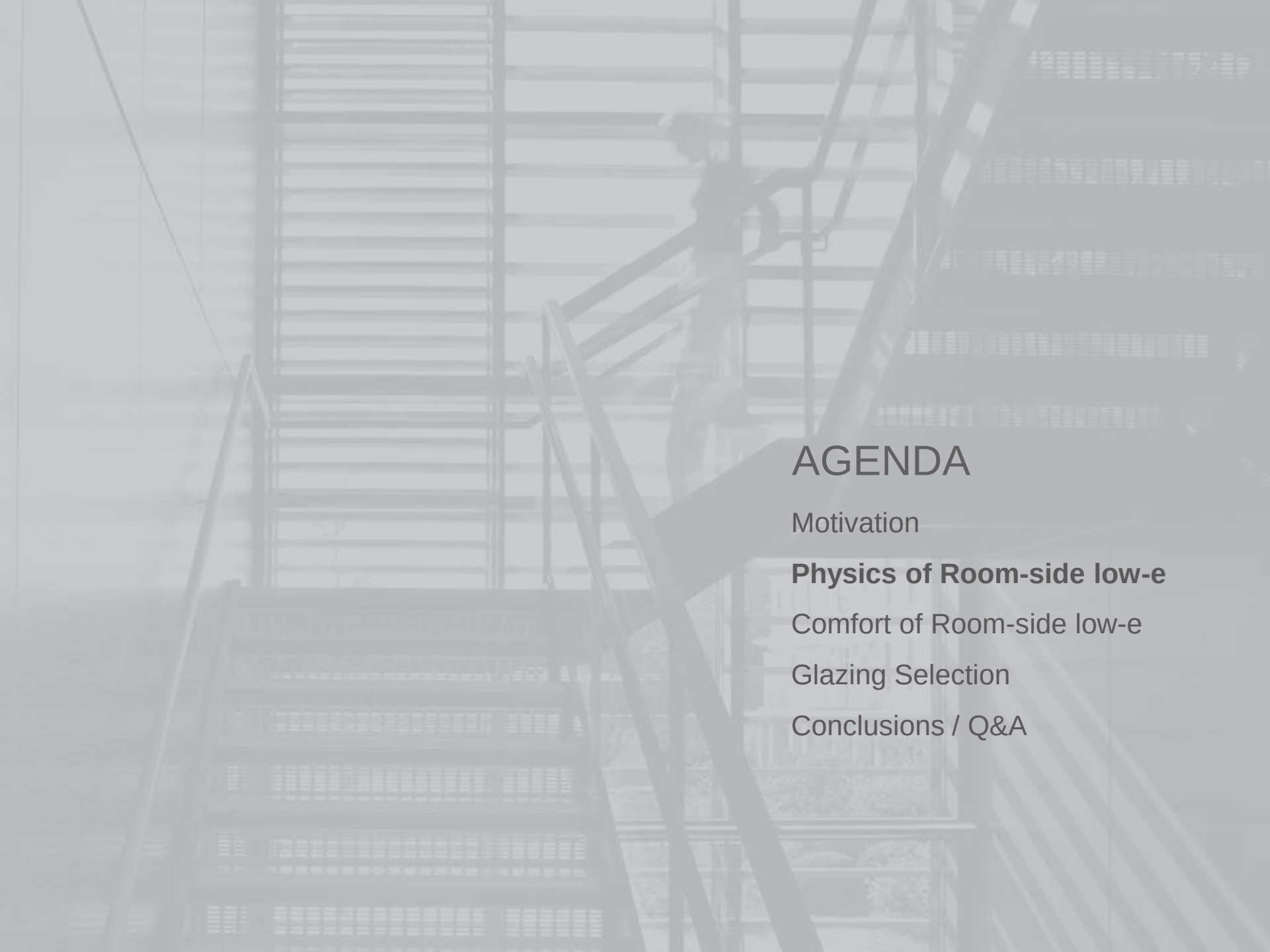
Motivation

Physics of Room-side low-e

Comfort of Room-side low-e

Glazing Selection

Conclusions / Q&A



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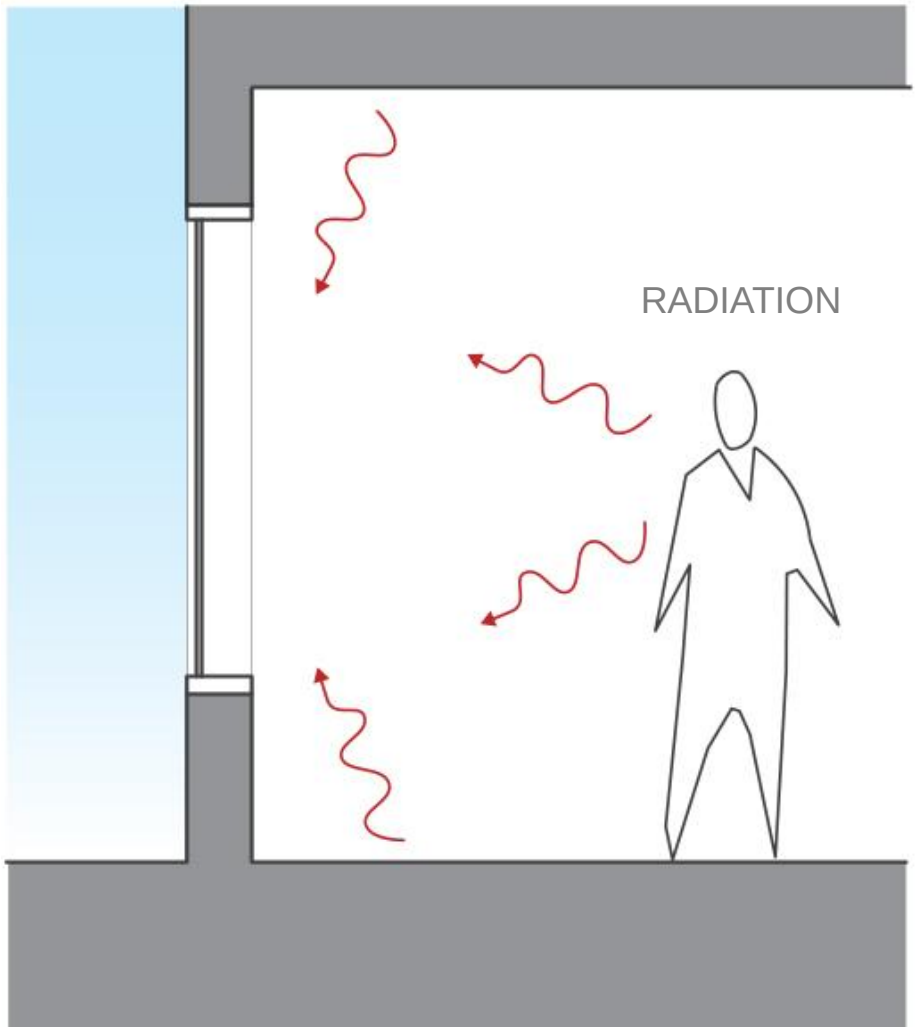
  - Radiation
  - Convection
  - Conduction



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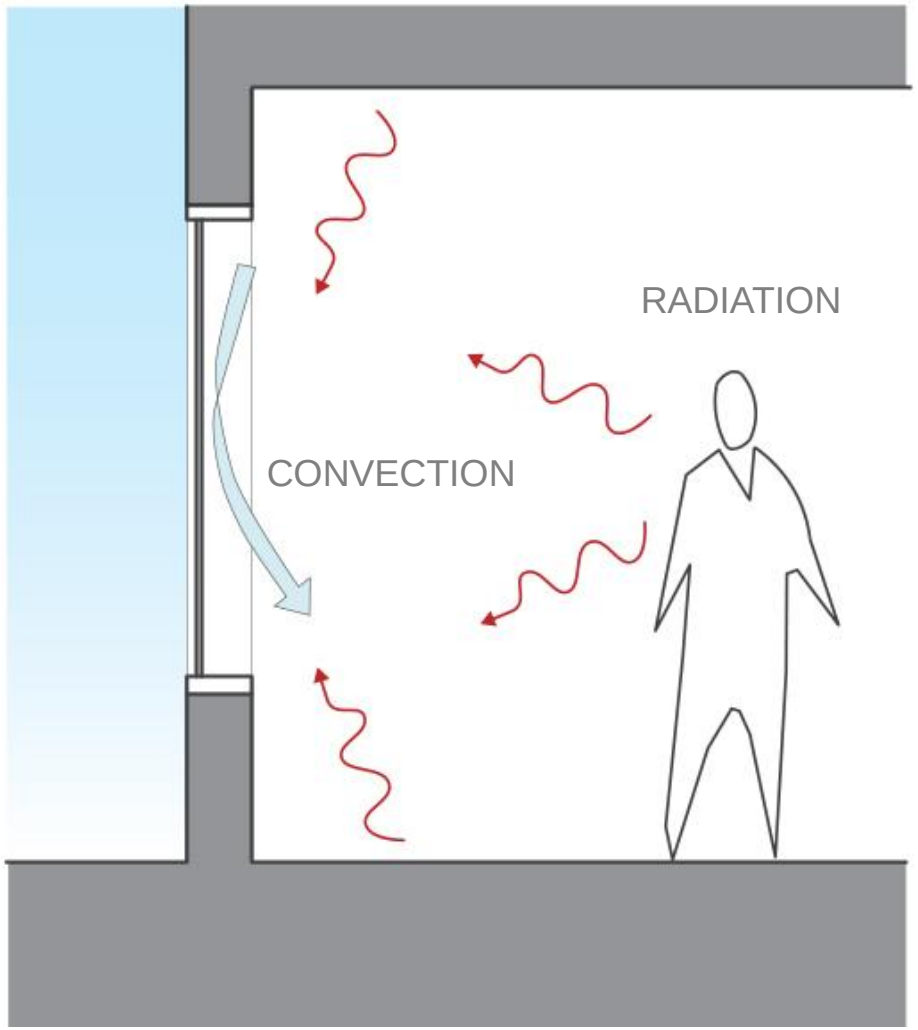

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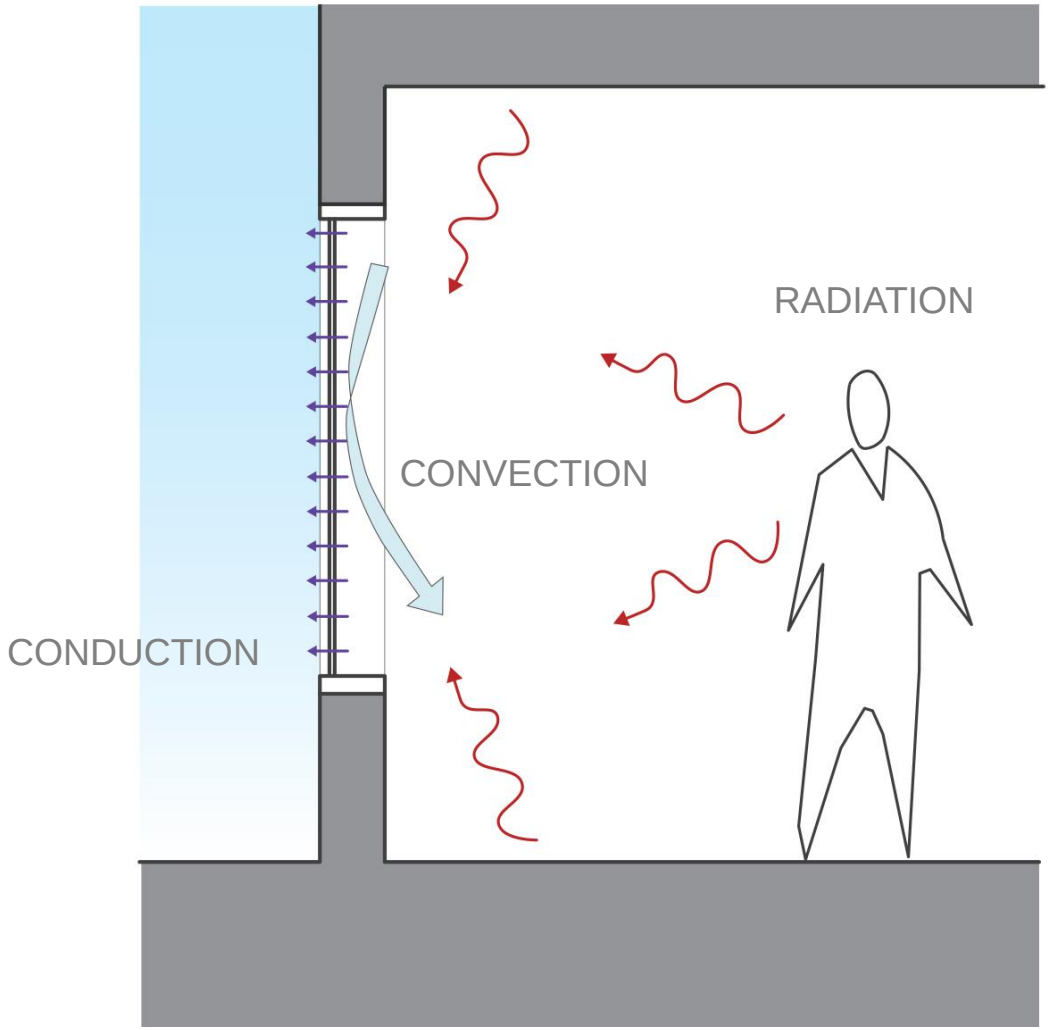

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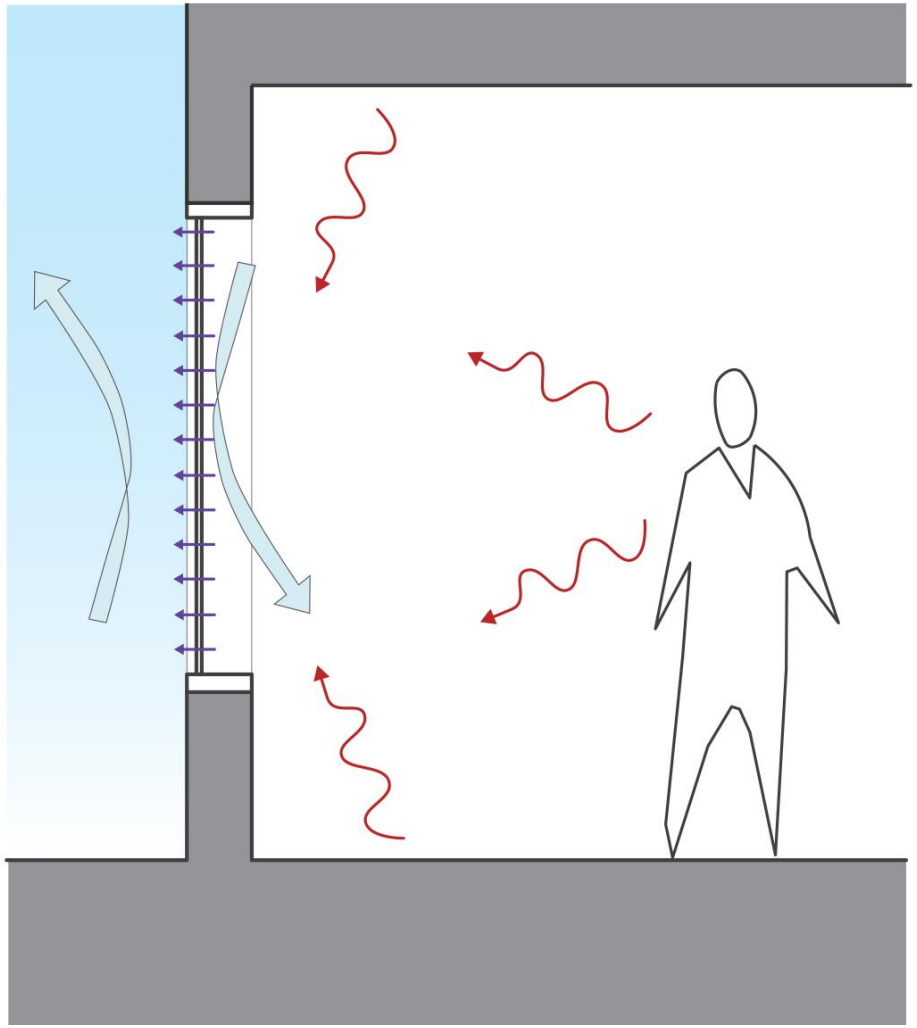

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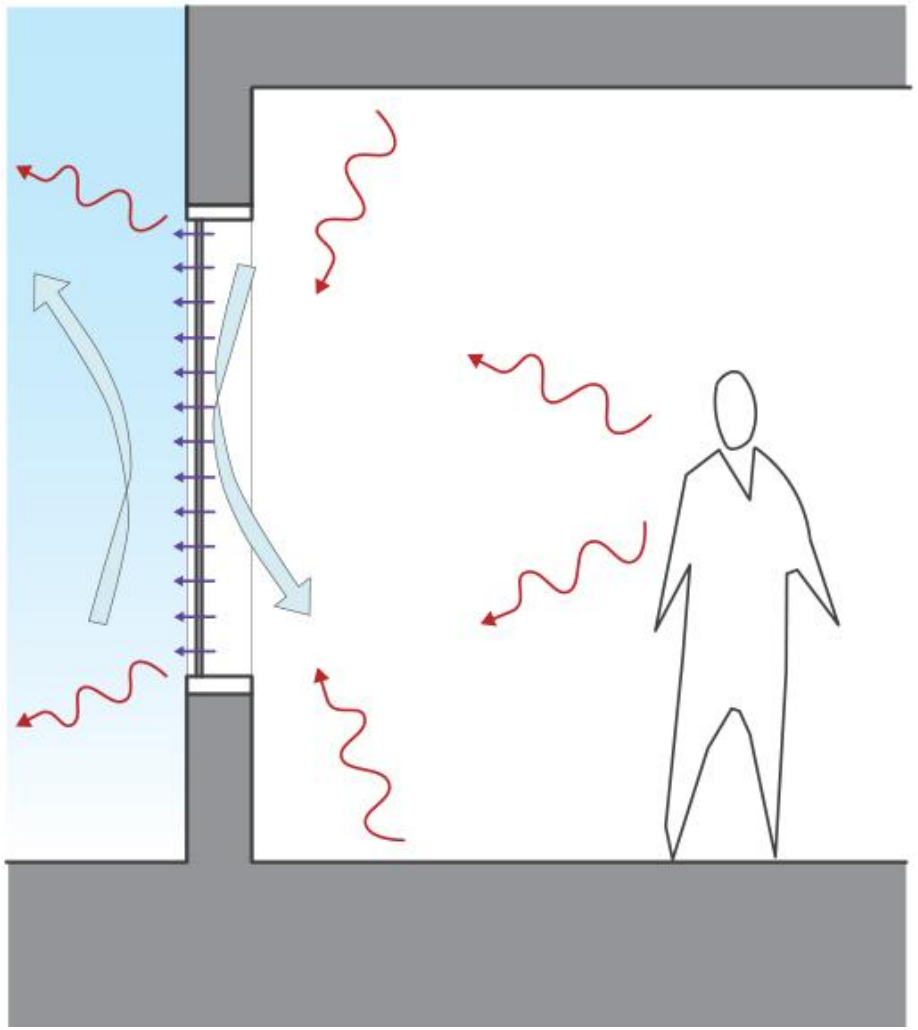
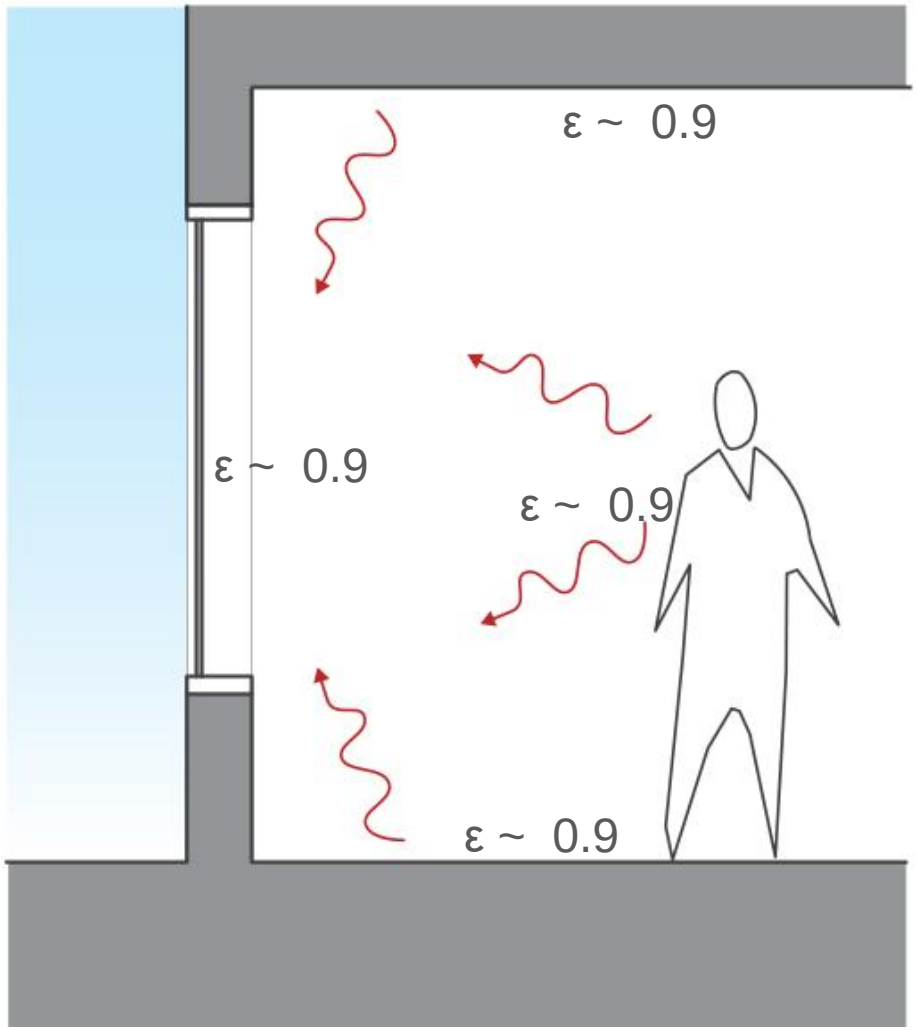


HEAT LOSS THROUGH GLASS | Radiation

- Radiative heat transfer between two surfaces depends on their:
  - Temperature
  - Area (view factor)
  - Emissivity (ε)



Typical surfaces	ε ~ 0.9
Room-side low-e coatings	ε ~ 0.2

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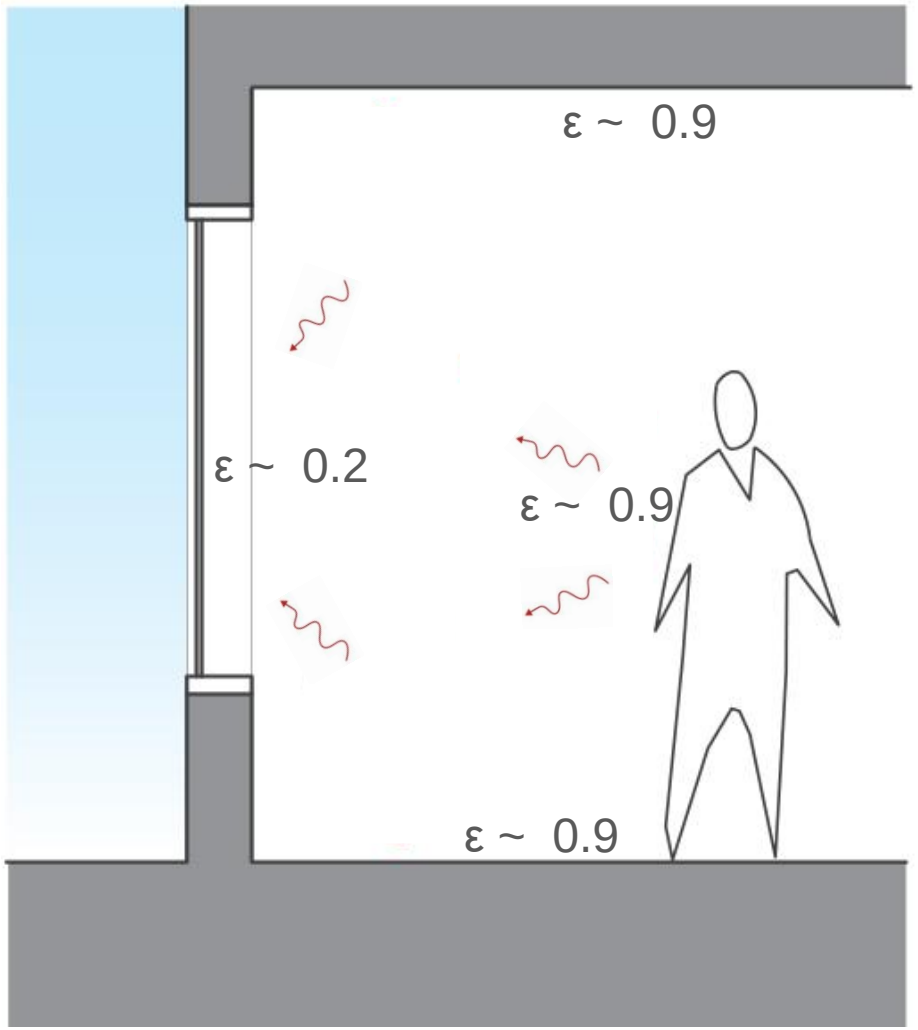

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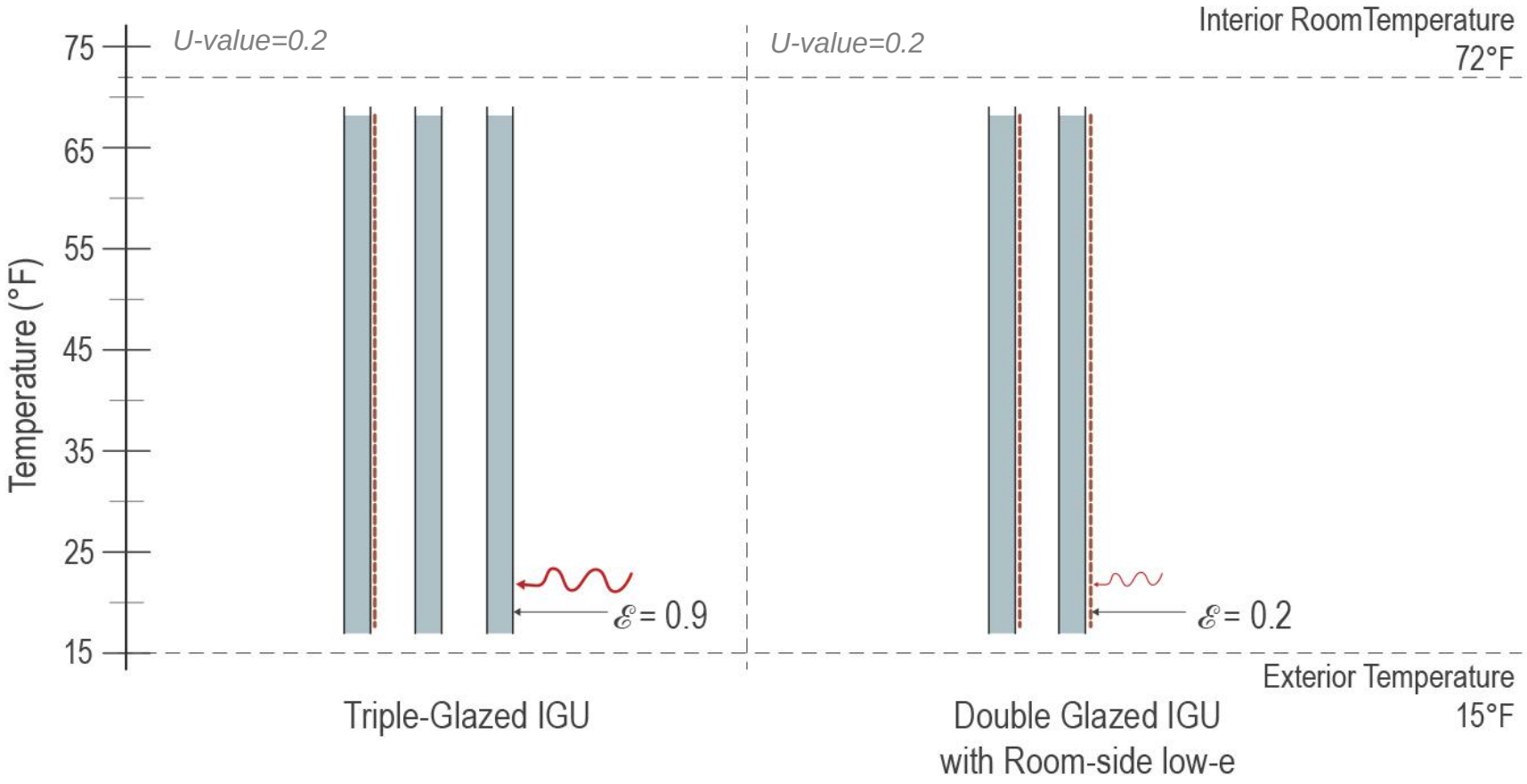
ROOM-SIDE LOW-E | Interior Surface Temperature



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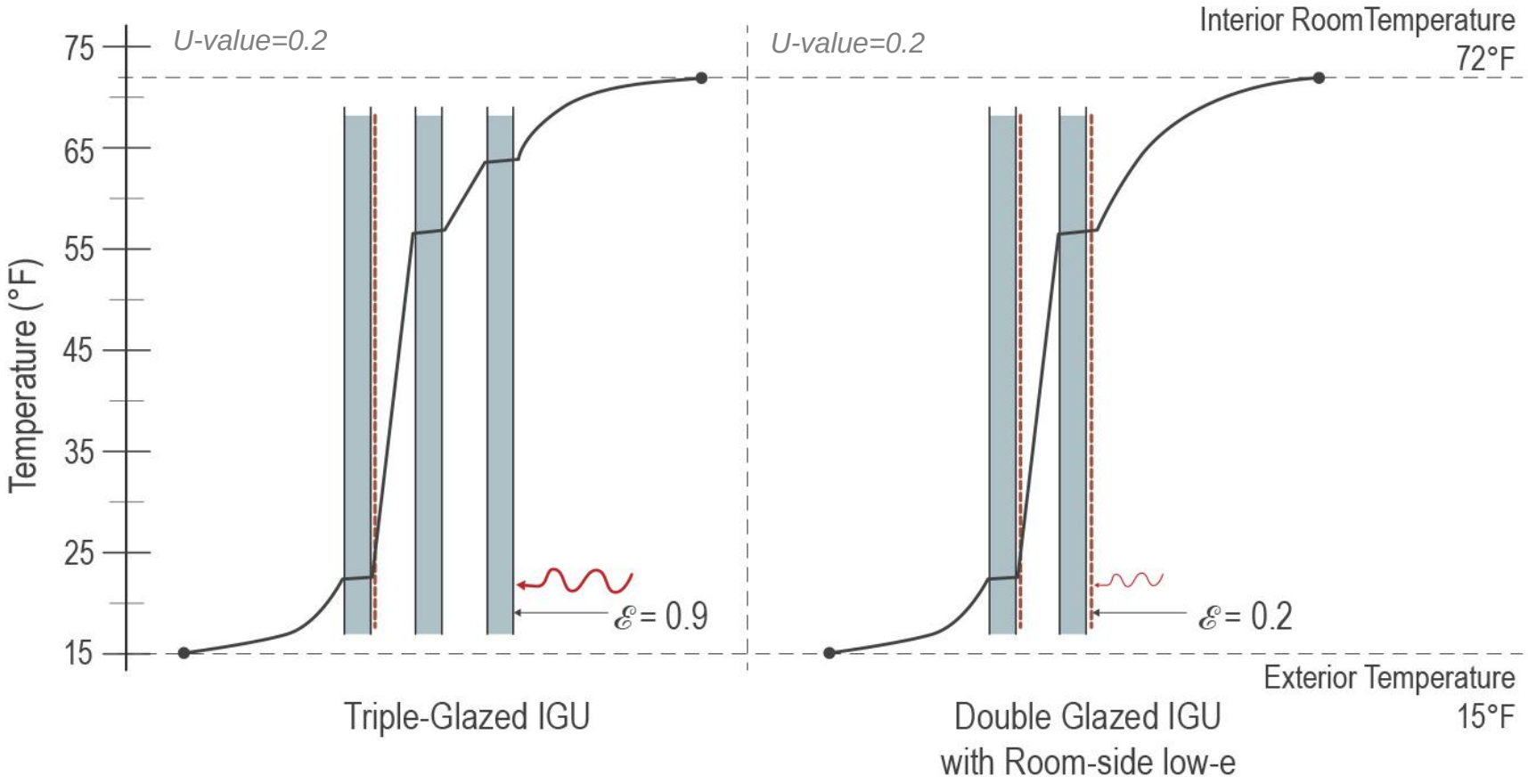

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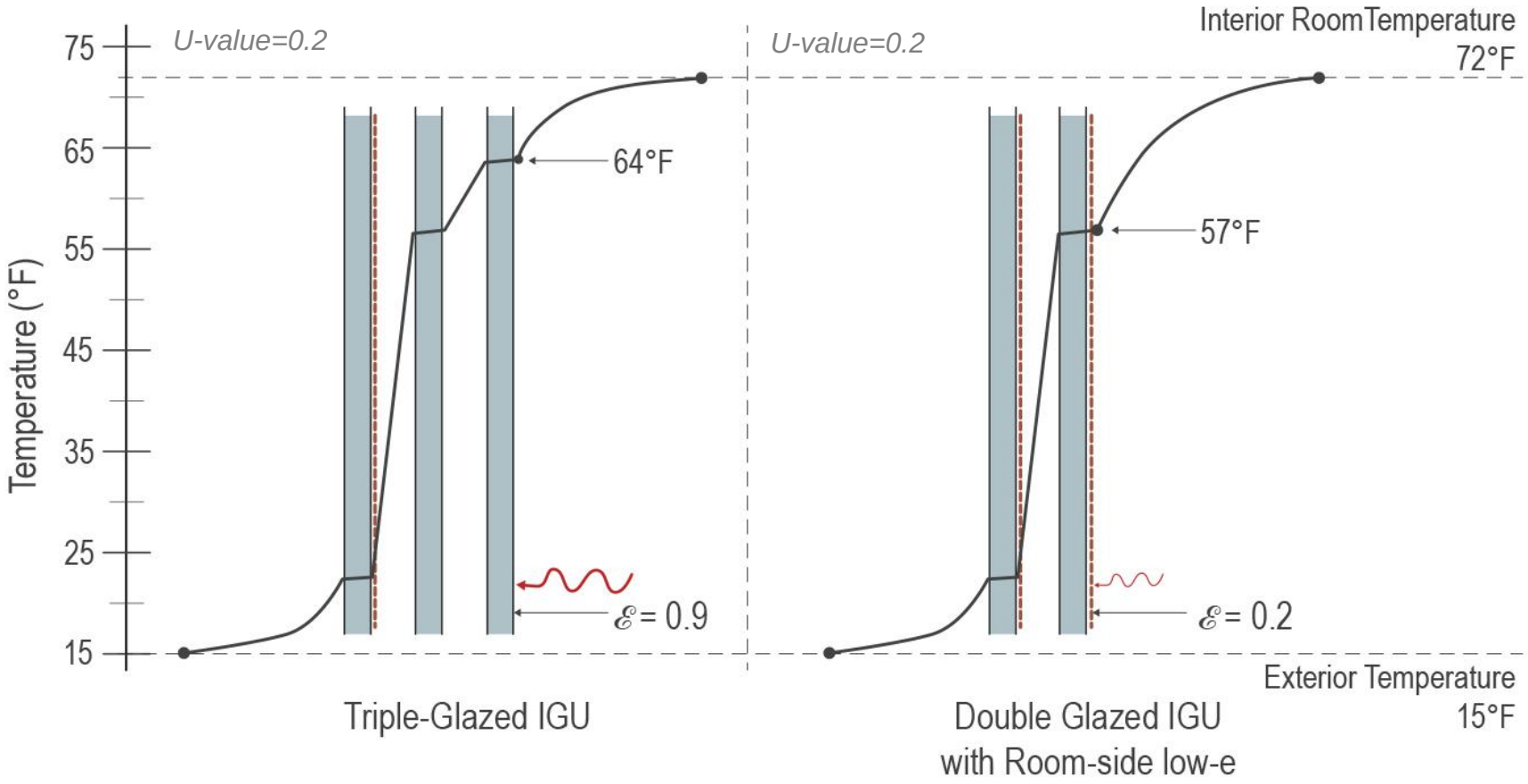

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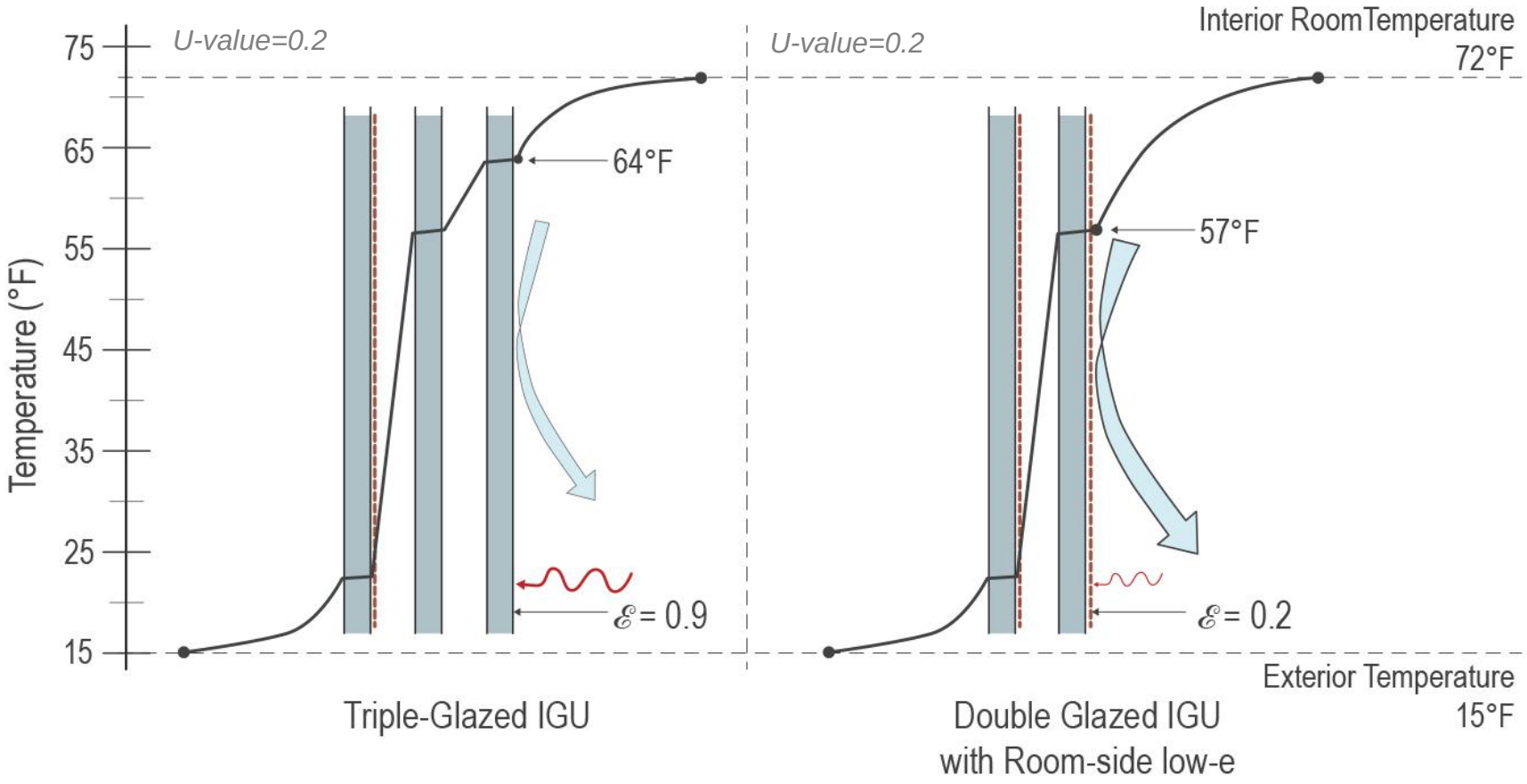
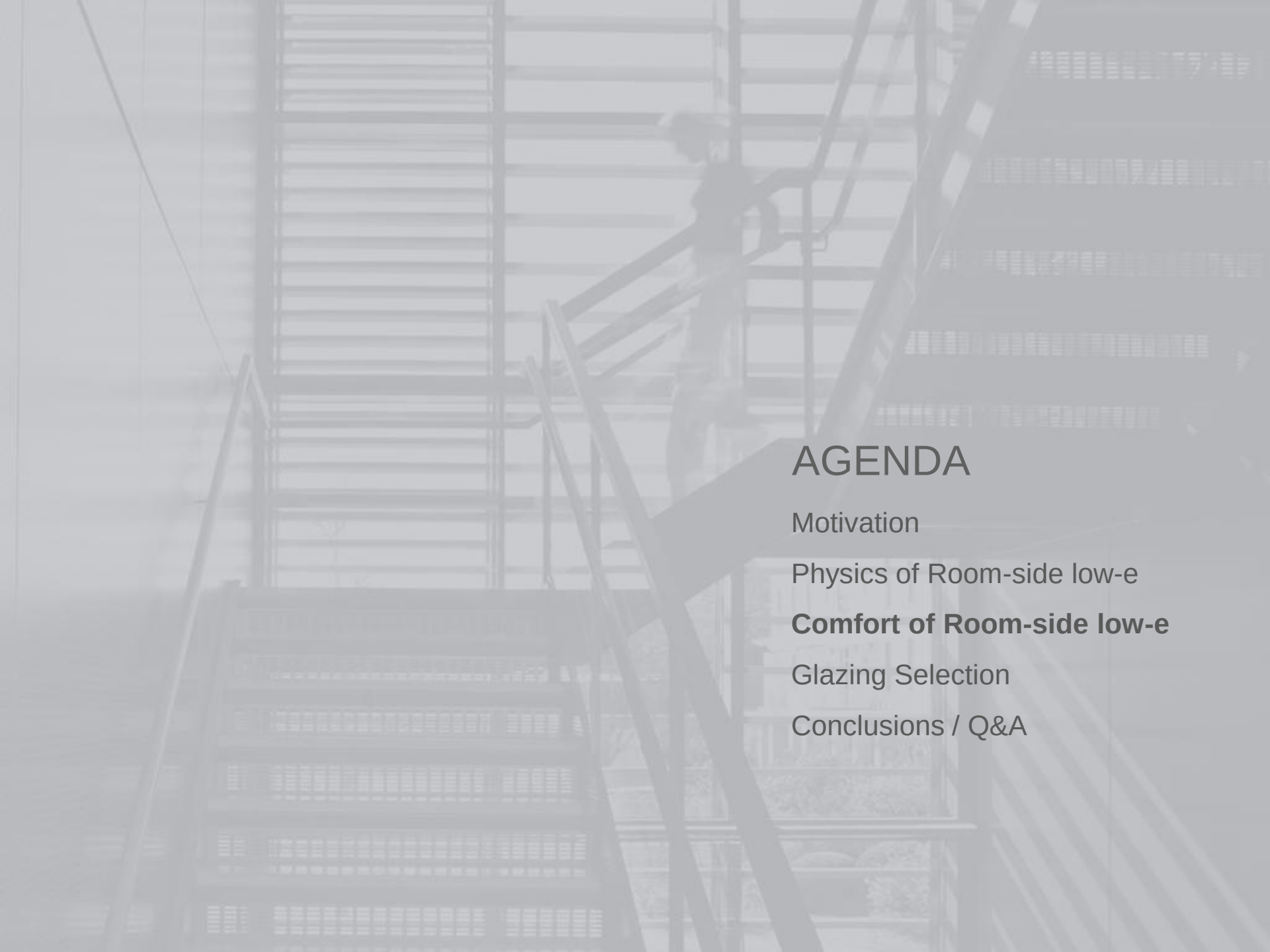


- Colder, stronger downdraft
- Potential for condensation



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THERMAL COMFORT

We feel cold when we lose heat:

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- Convection
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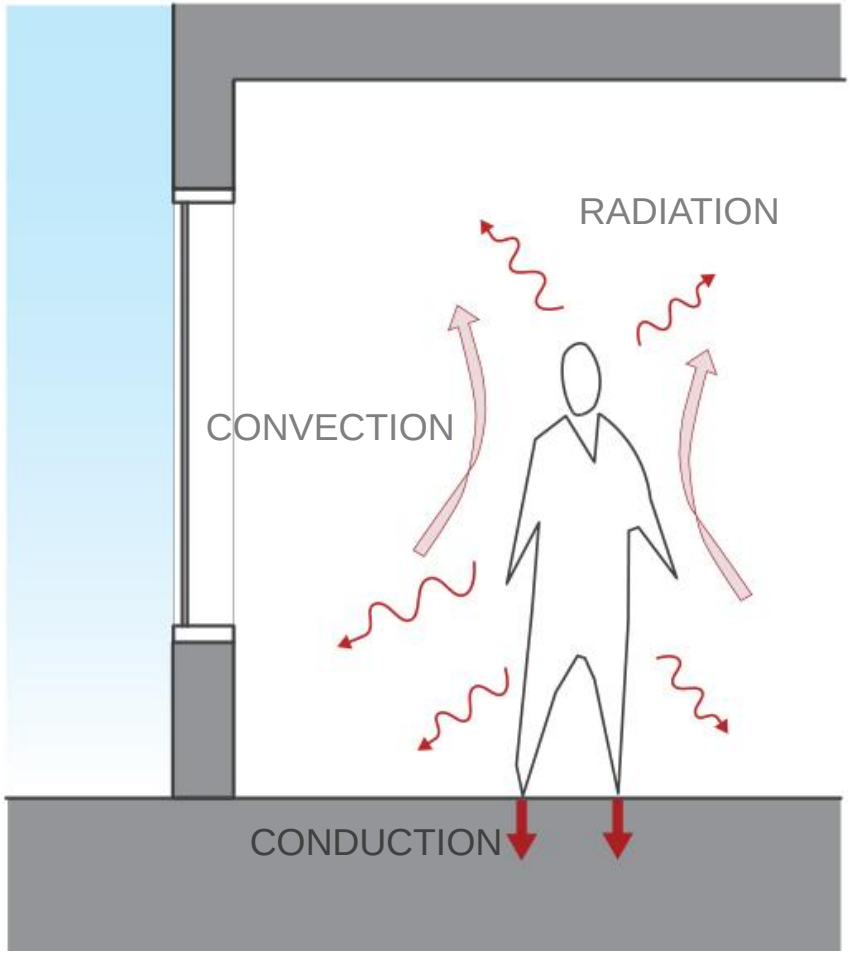

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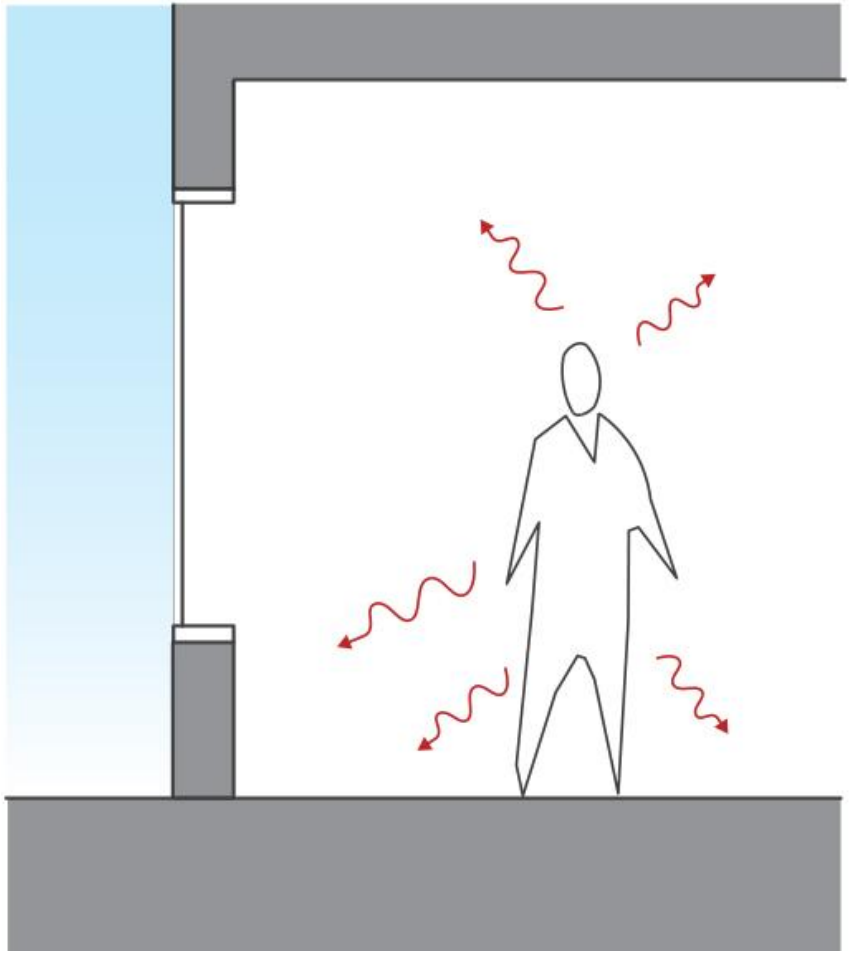

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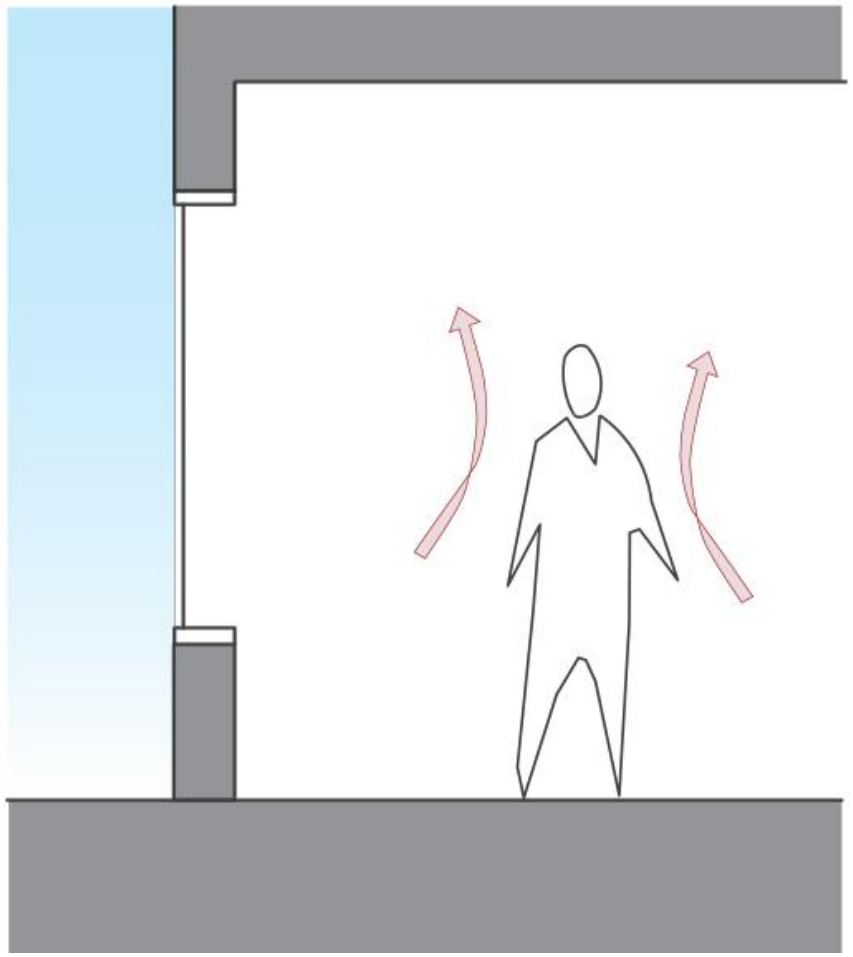

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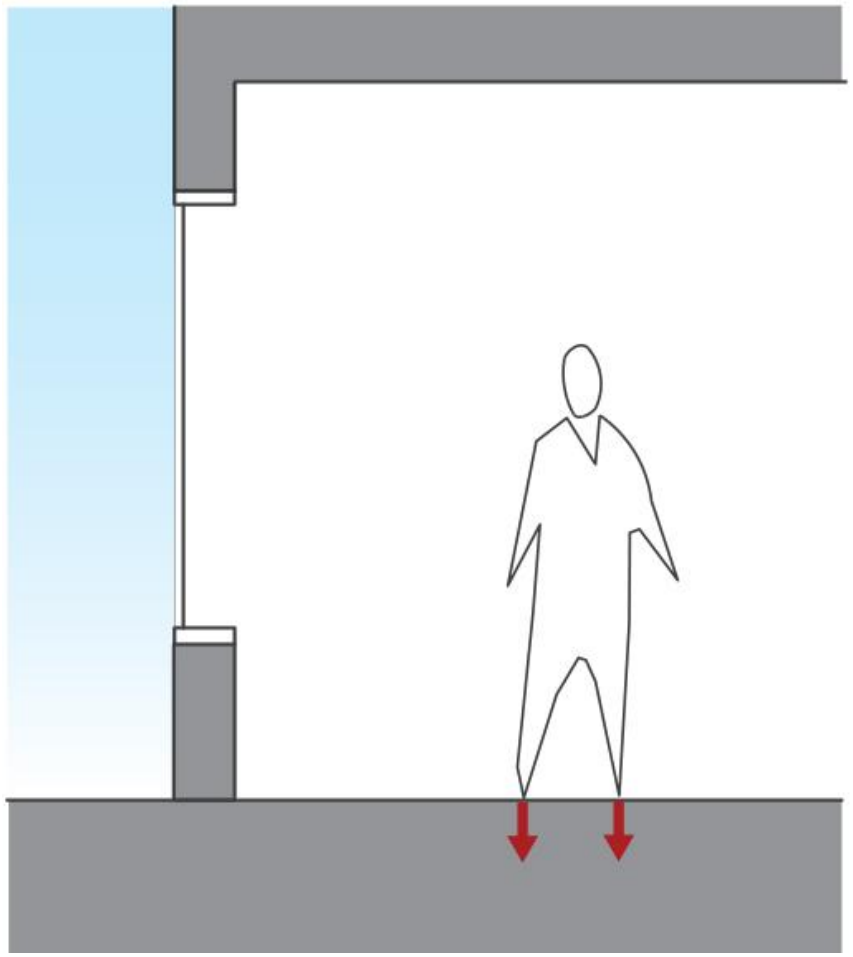
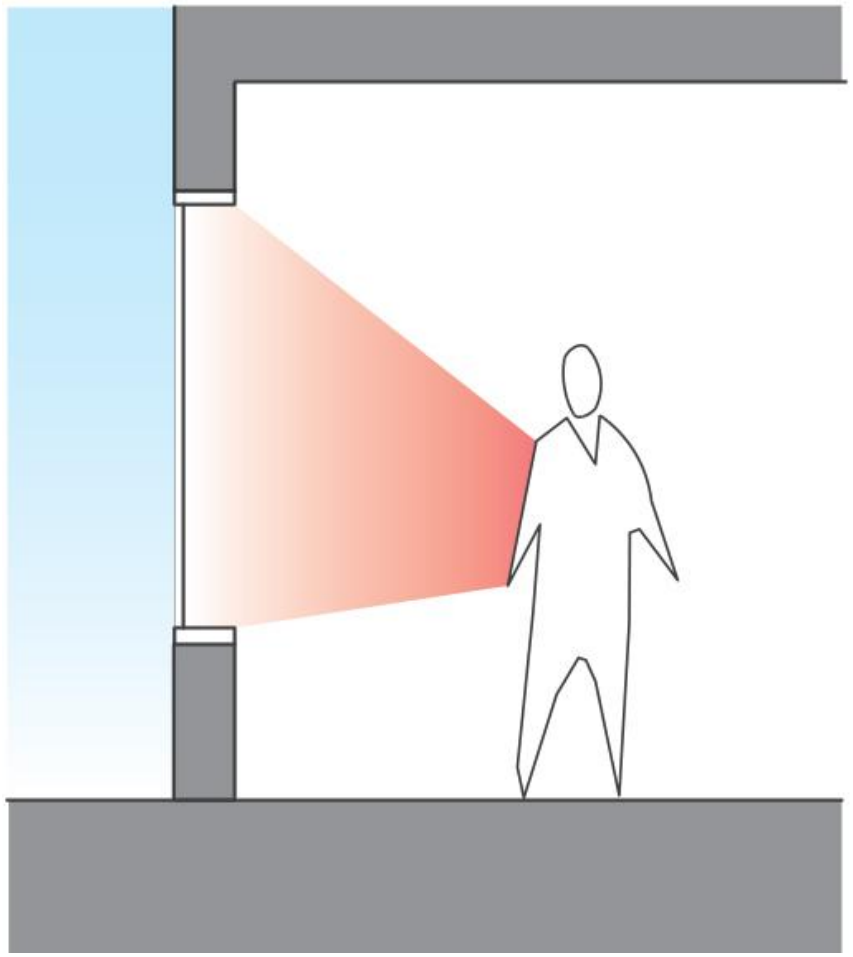


THERMAL COMFORT | Glazing

Exterior glazing makes us feel cold:

- We lose heat to the glass



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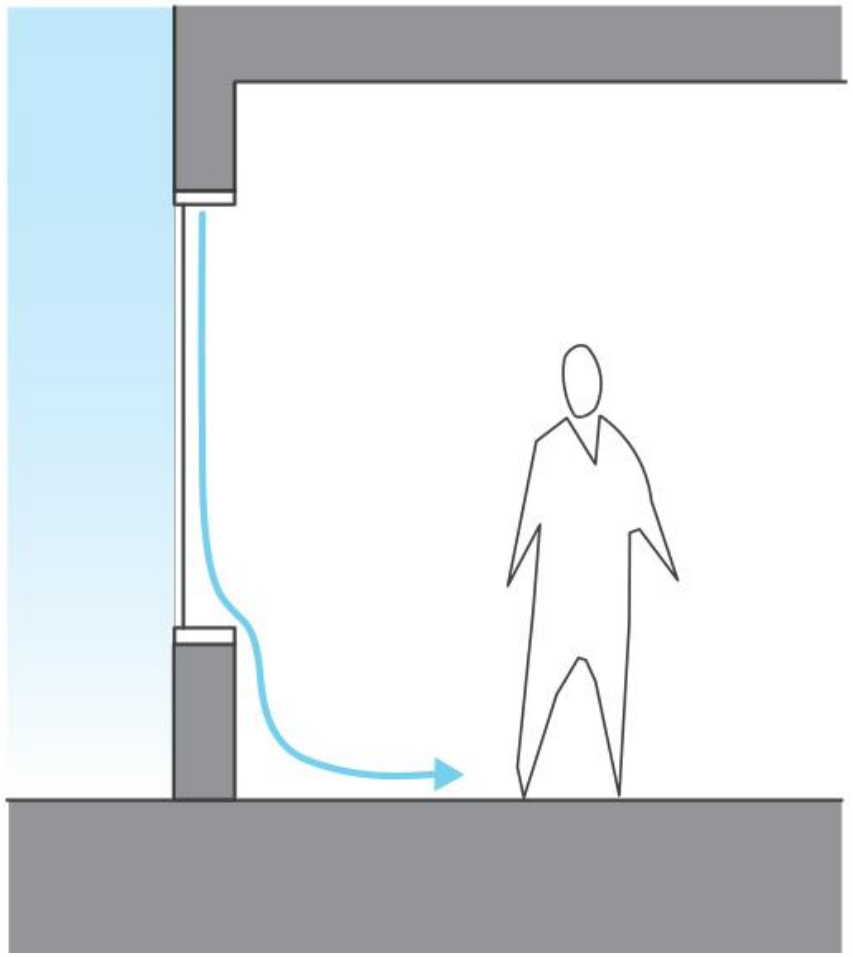
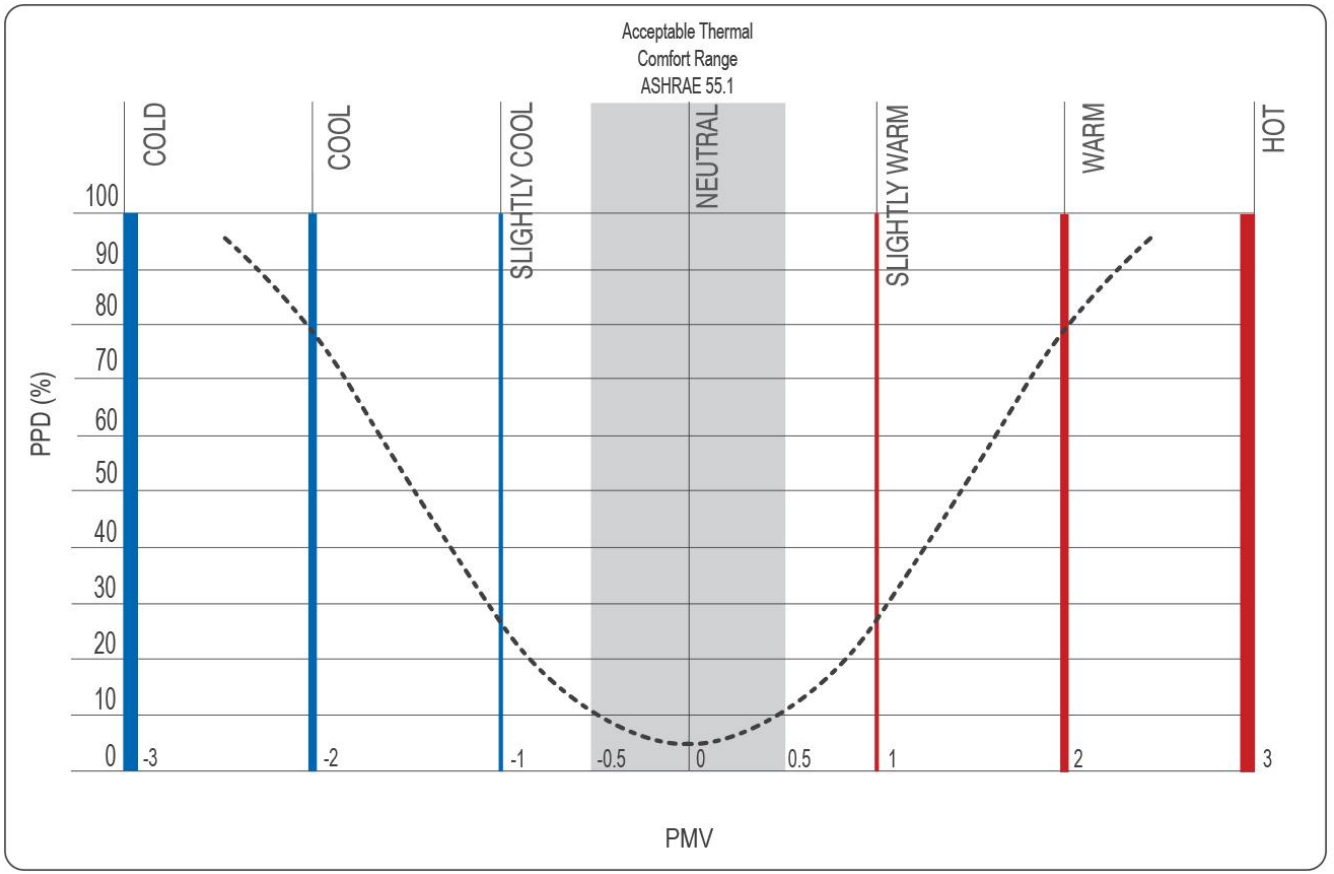
Exterior glazing makes us feel cold:

- We lose heat to the glass
- We get cold hands and feet due to downdraft



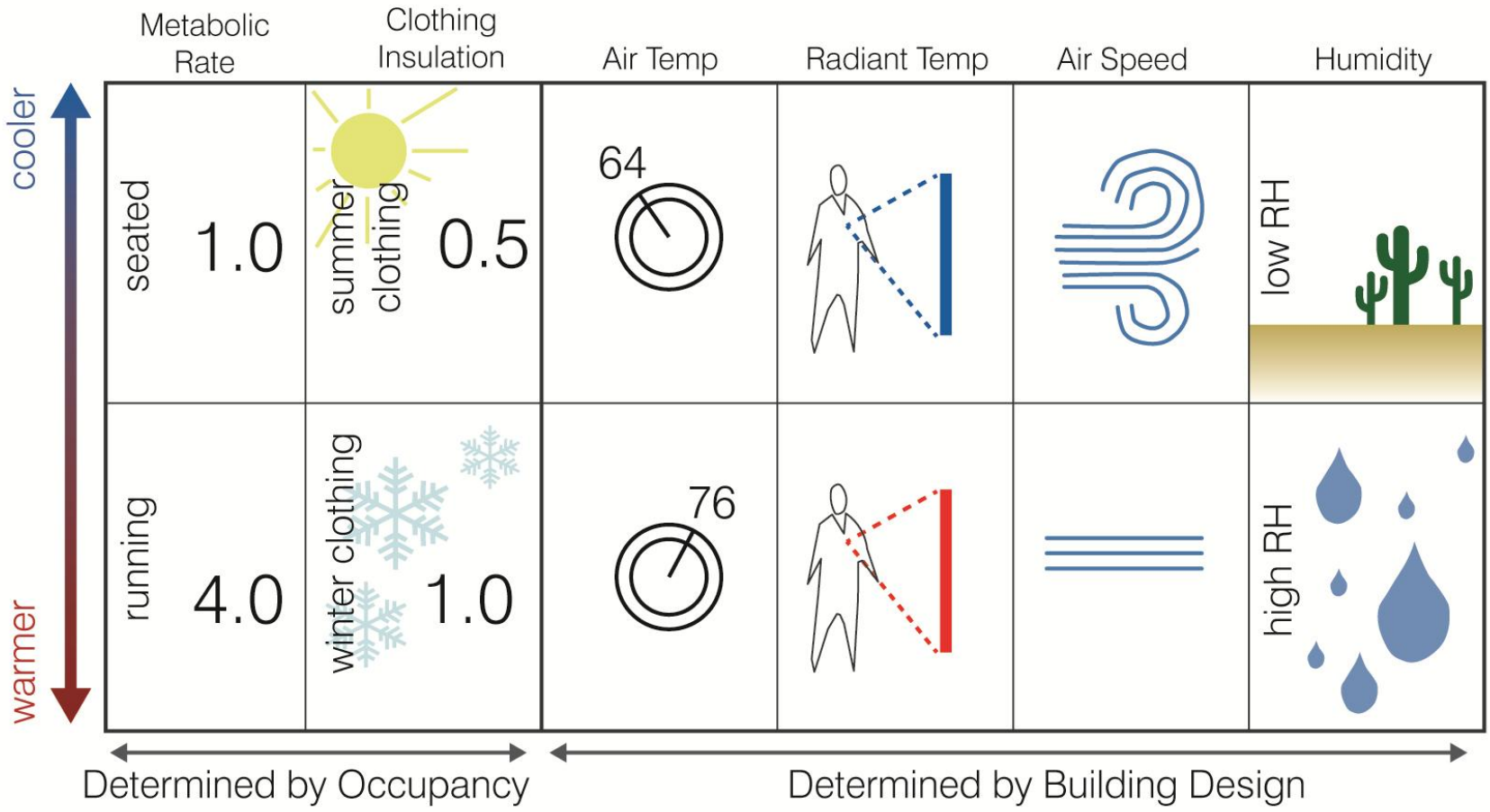
THERMAL COMFORT | Predicted Percentage Dissatisfied



- Predicted Percentage Dissatisfied (PPD) less than 10%
- Predicted Mean Vote (PMV) Range -0.5 to +0.5

Thermal Comfort. P. O. Fanger (1970), Copenhagen: Danish Technical Press.

THERMAL COMFORT | Quantifying Radiant Discomfort



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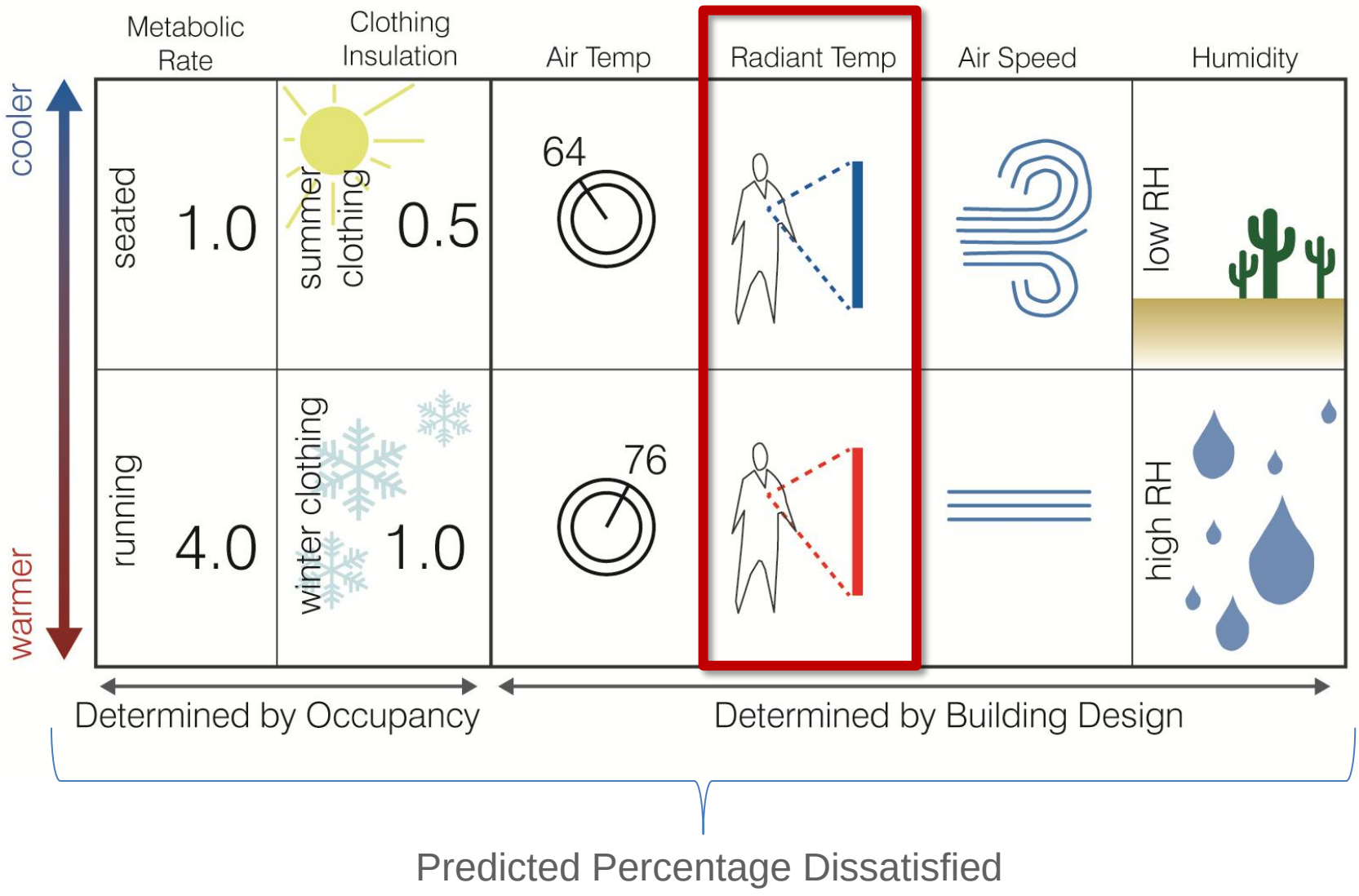

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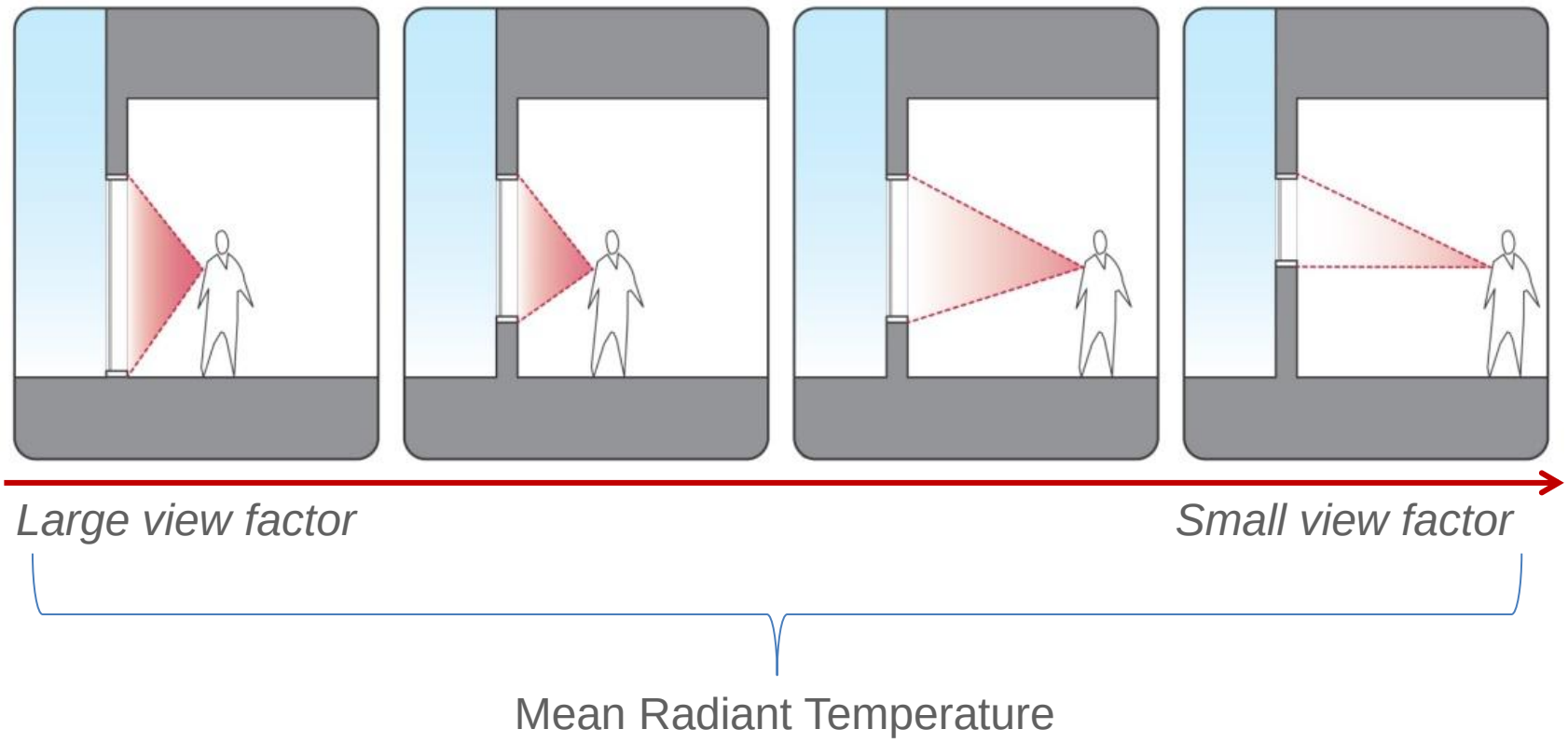

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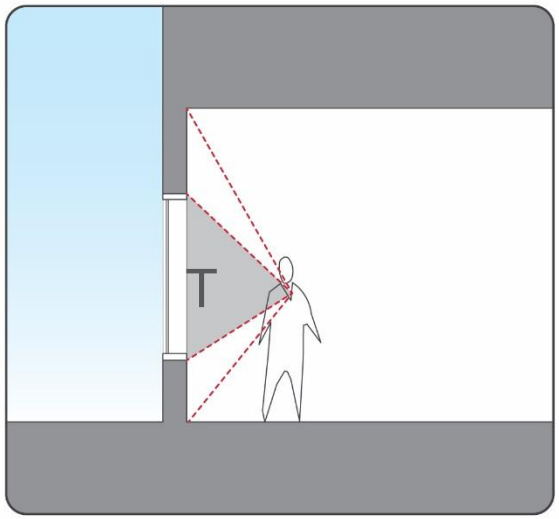
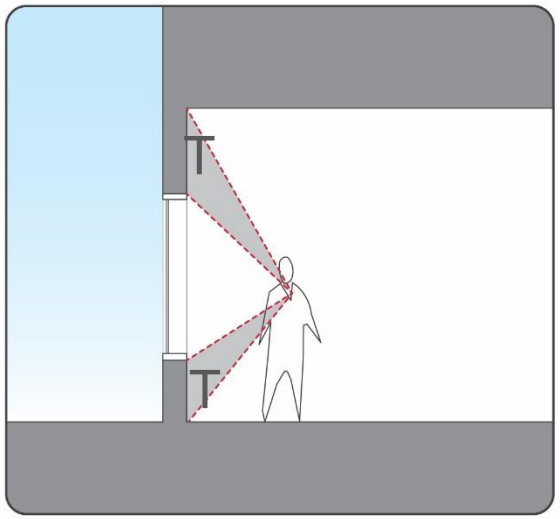
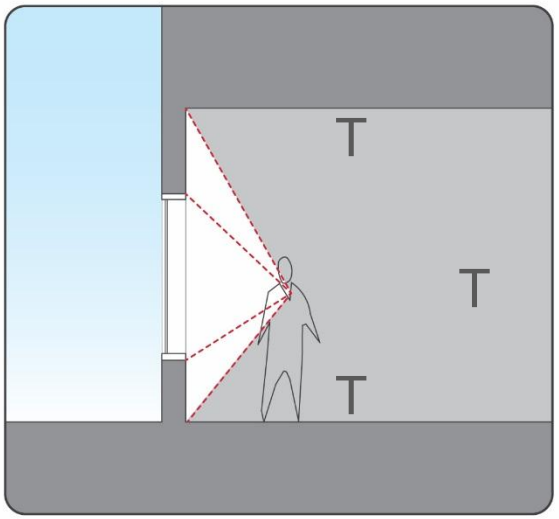
Glazing



Solid wall



Interior surroundings



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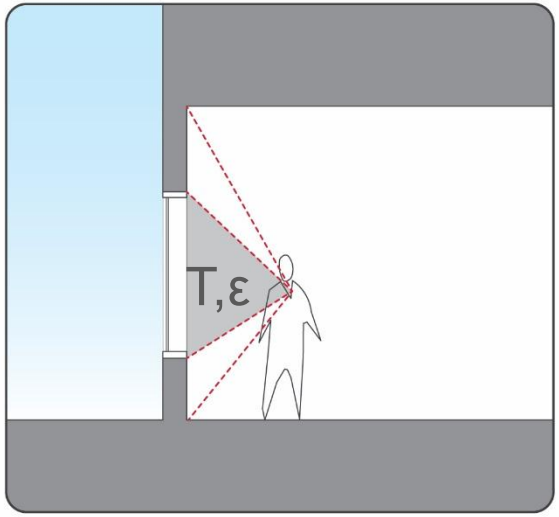

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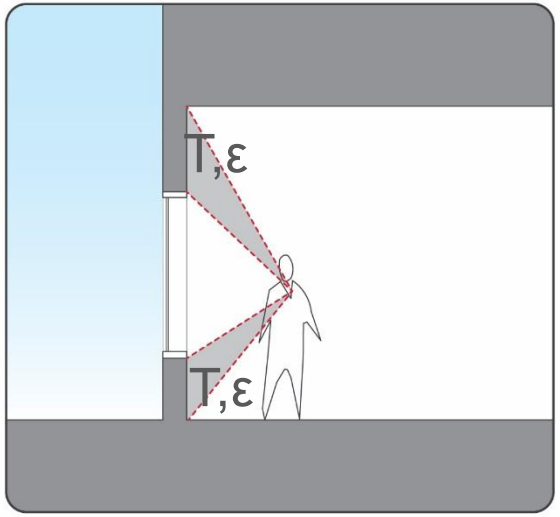

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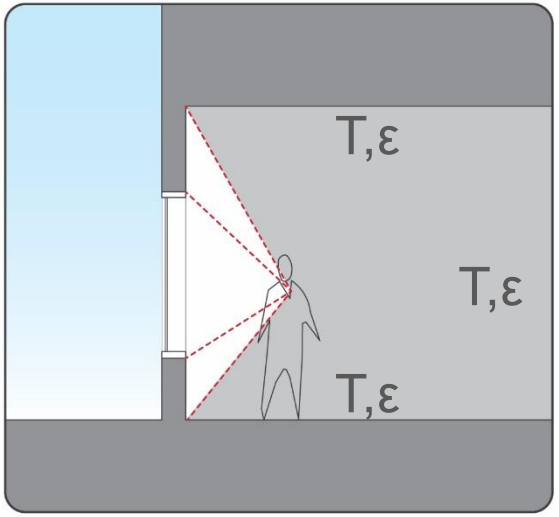
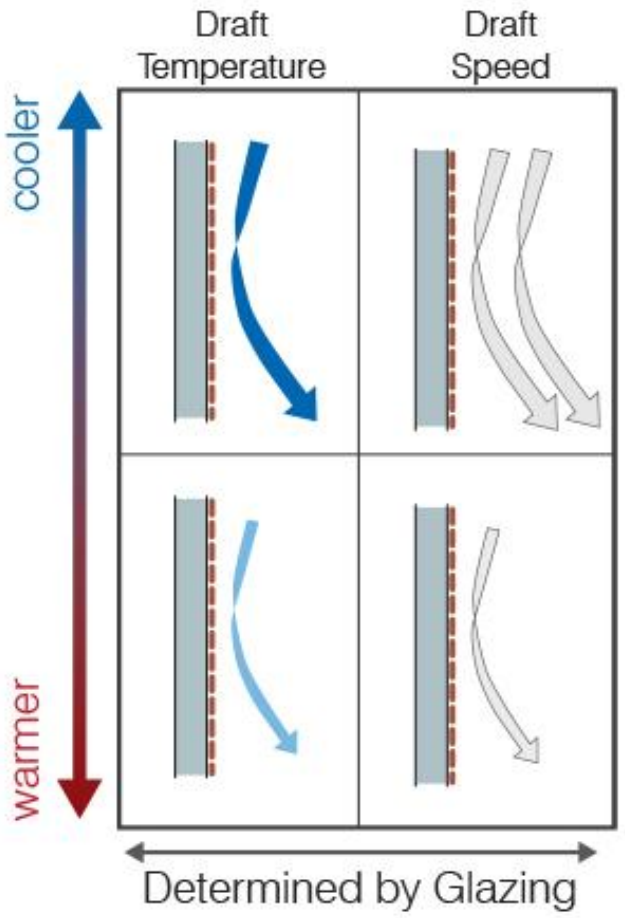


THERMAL COMFORT | Quantifying Draft Discomfort



Air Turbulence and Sensation of Draft. P. O. Fanger (1988), Energy and Buildings, 12, pp. 21-39.
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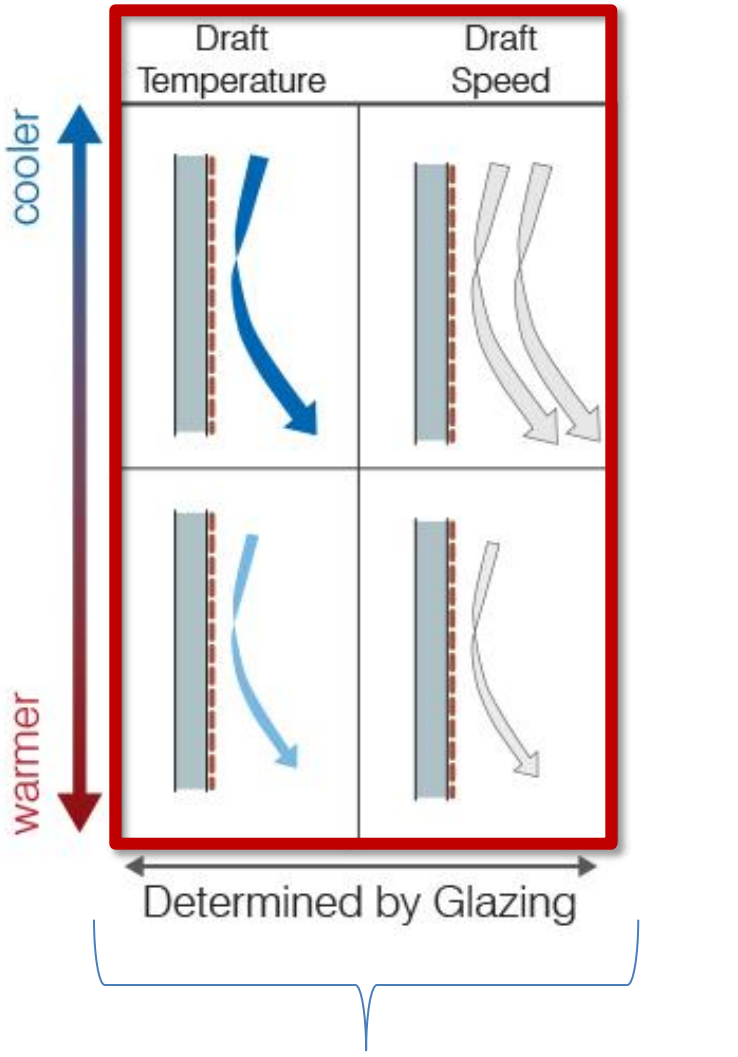

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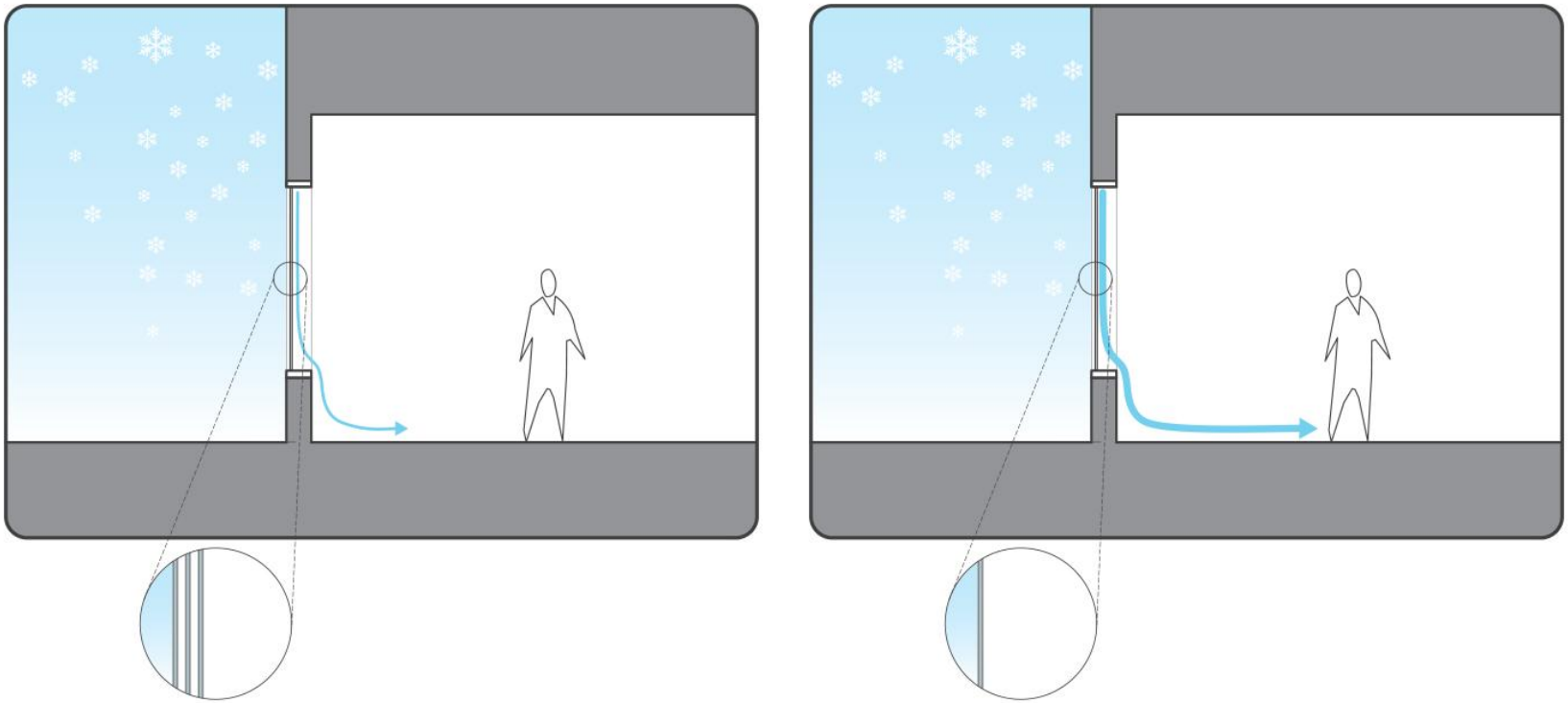

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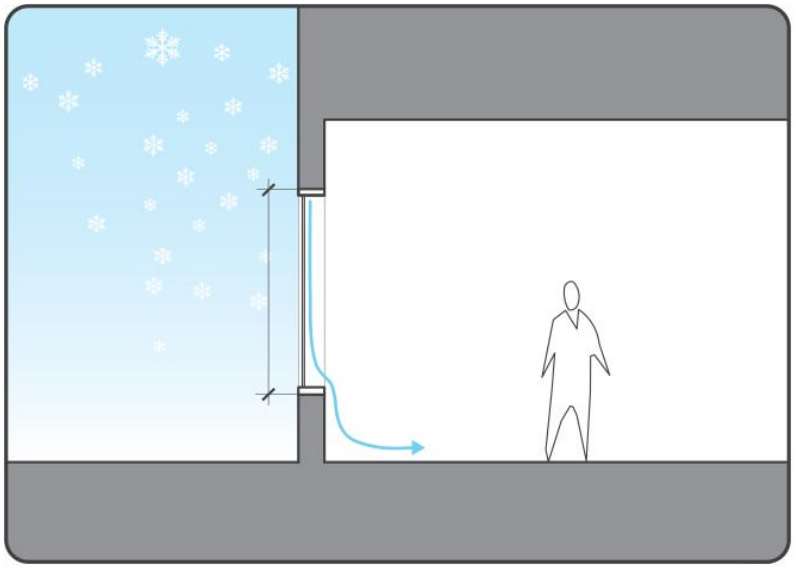

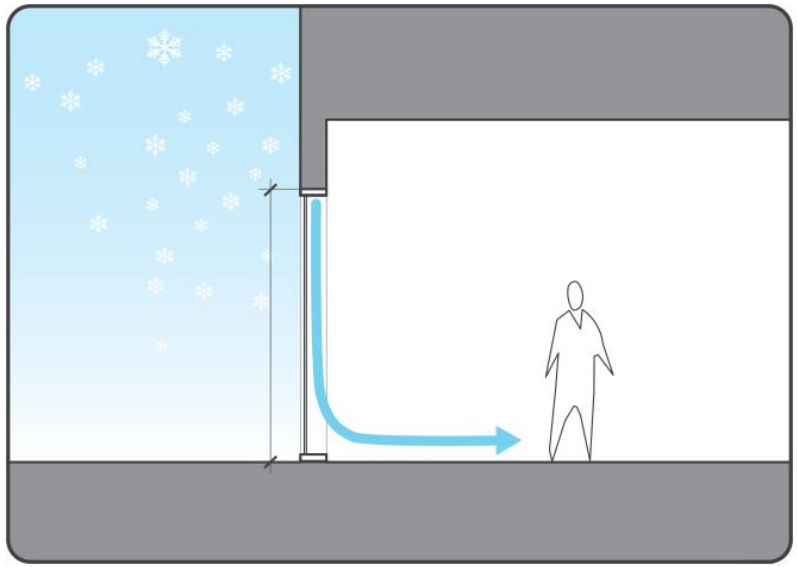

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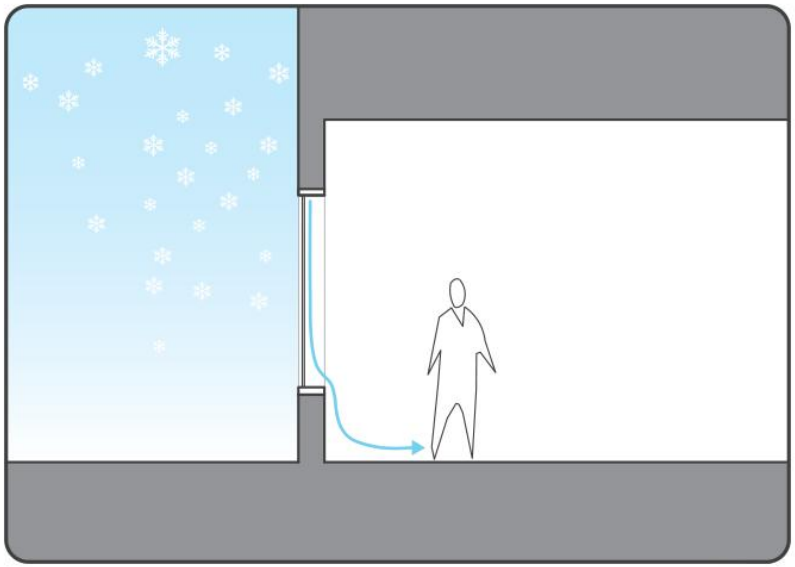
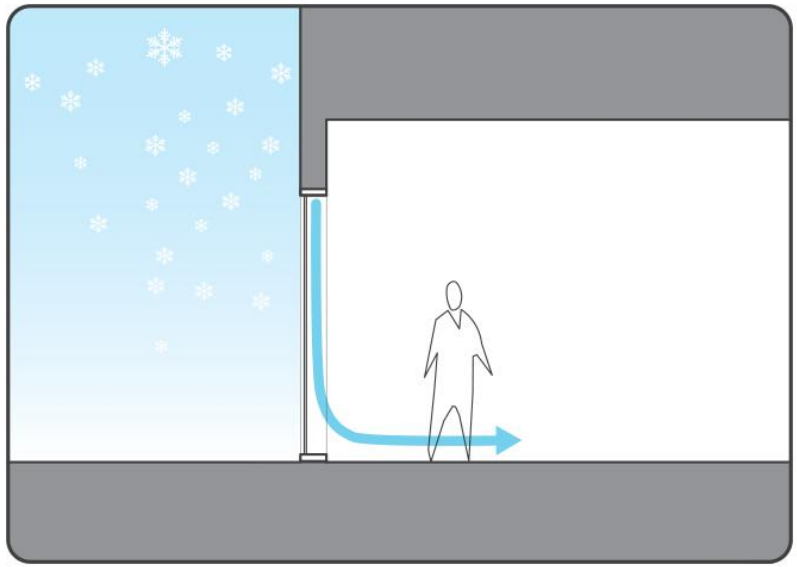
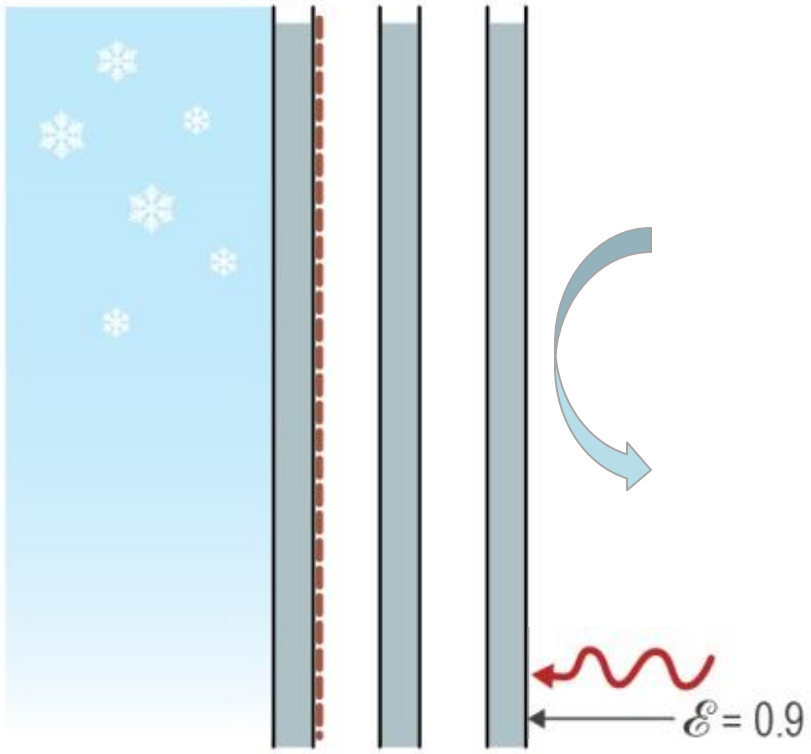




THERMAL COMFORT | Key Differences



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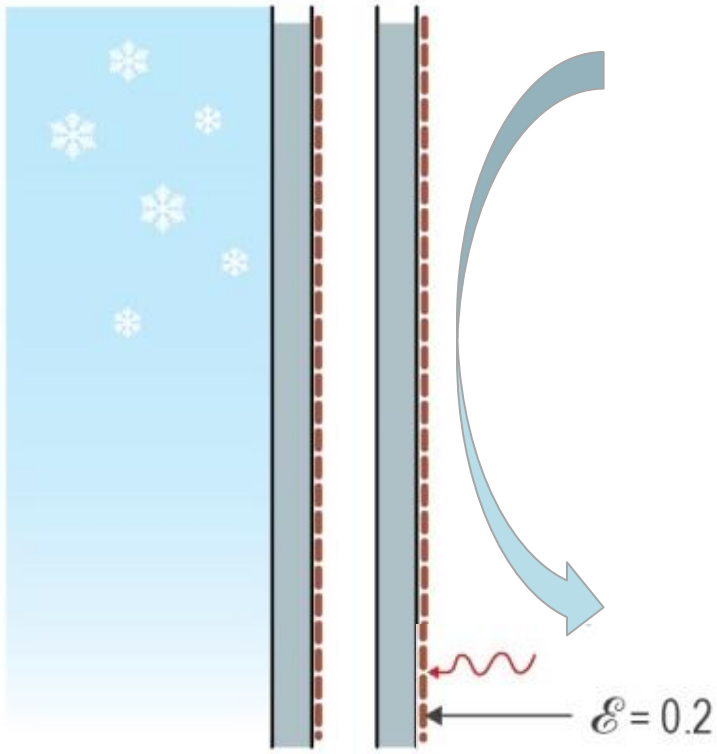

Double-Glazed IGU
with Room-side low-e

- Radiant comfort: not affected (improved)
- Increased risk of downdraft (tall windows)
- Increased risk of condensation

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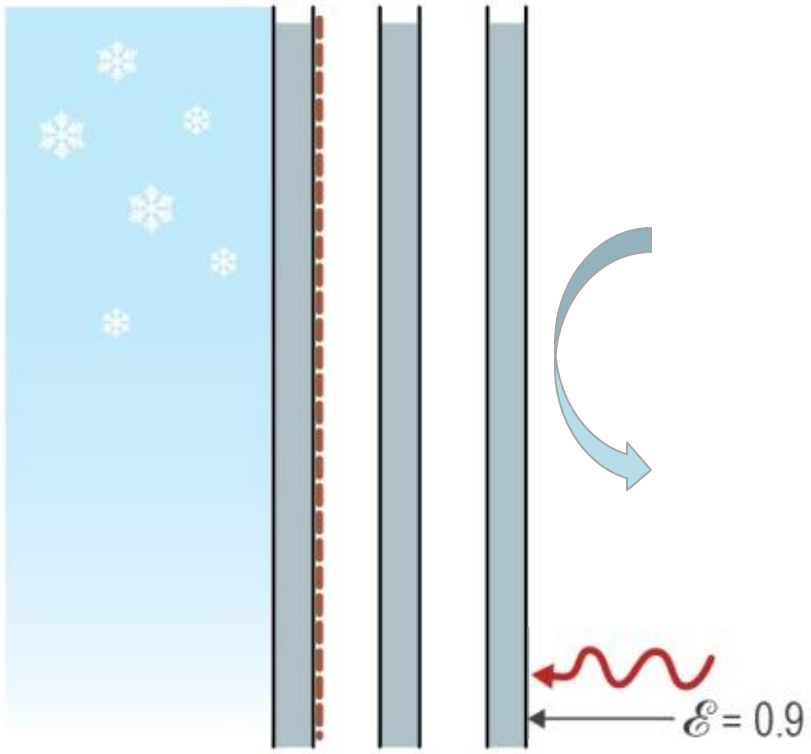

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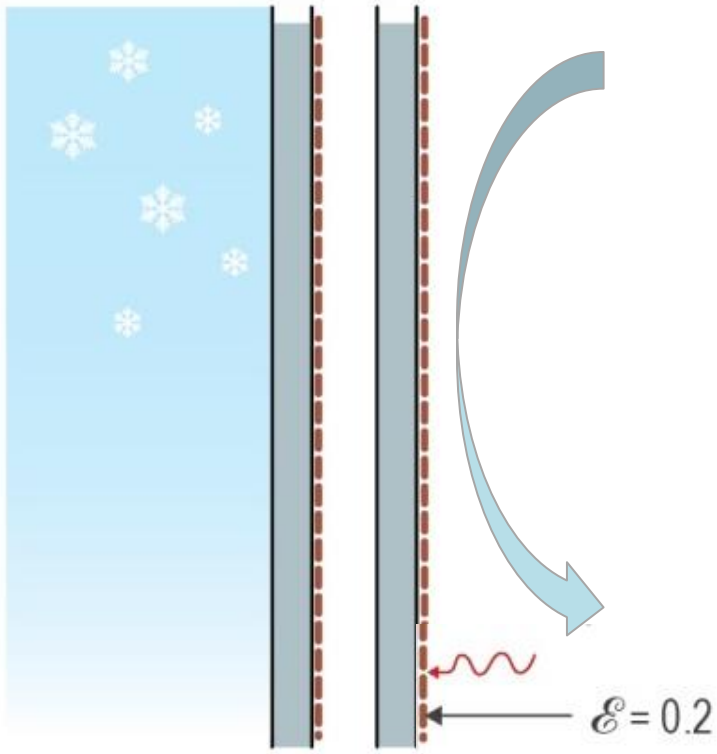
- Use with tall windows
- Use in high humidity environments



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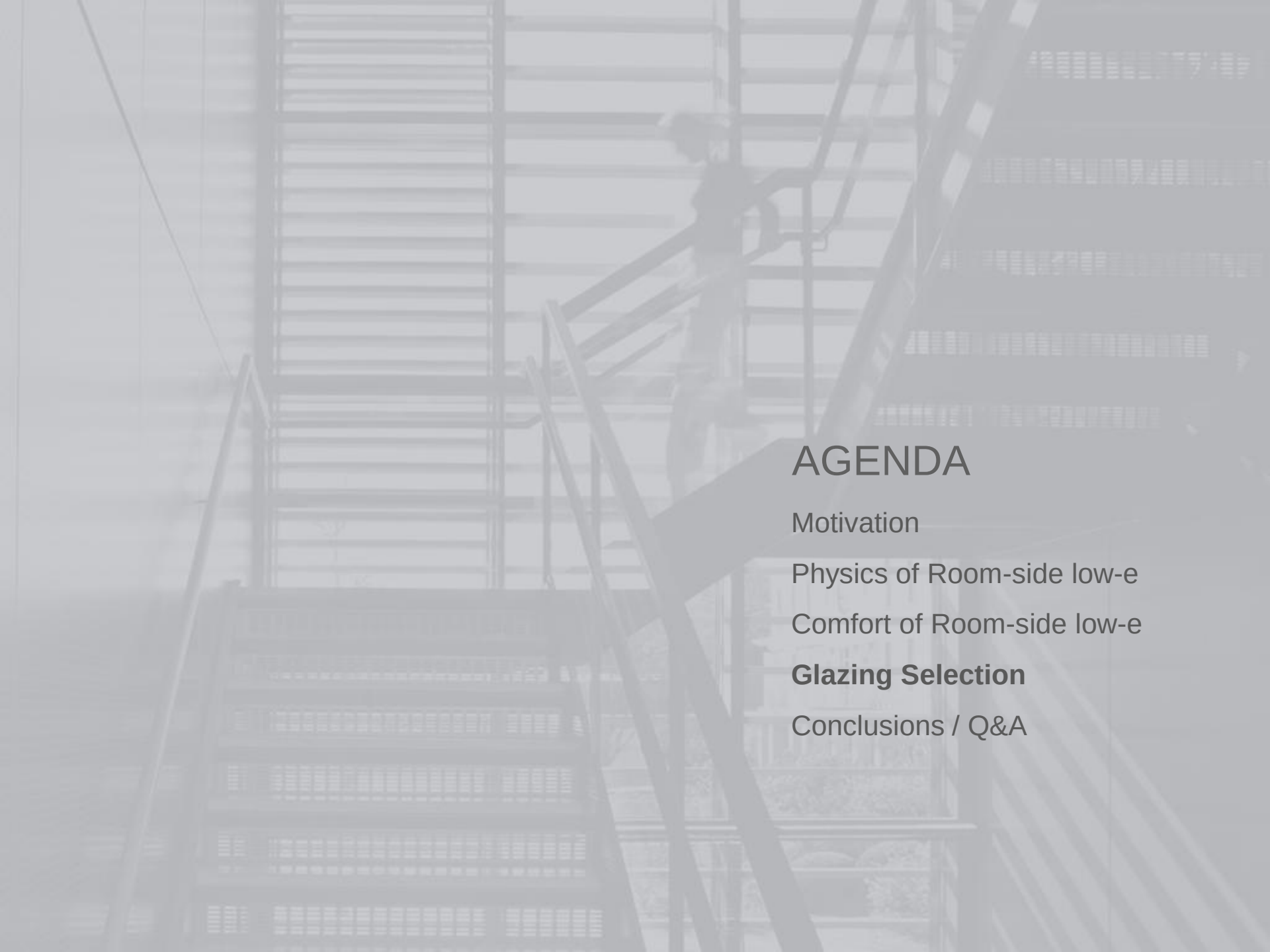
- Use with shorter windows
- Use with low winter humidity spaces



AGENDA

Motivation

Physics of Room-side low-e

Comfort of Room-side low-e

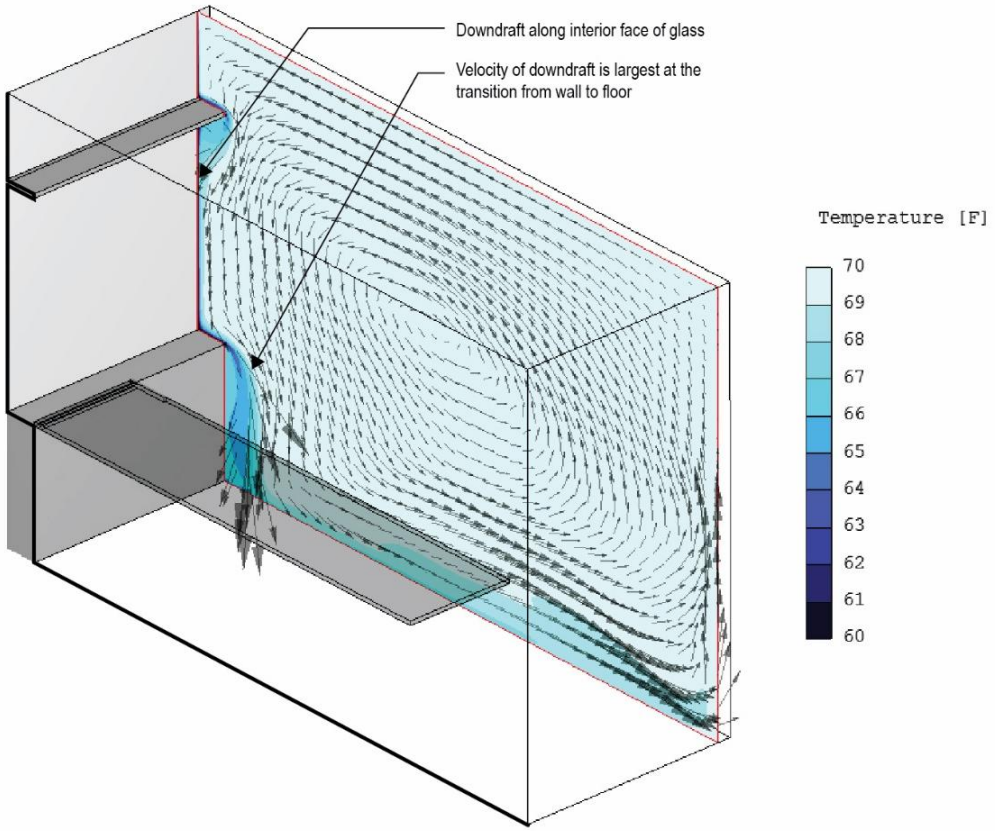
Glazing Selection

Conclusions / Q&A

HOW TO SELECT THE RIGHT GLAZING?

Goal:

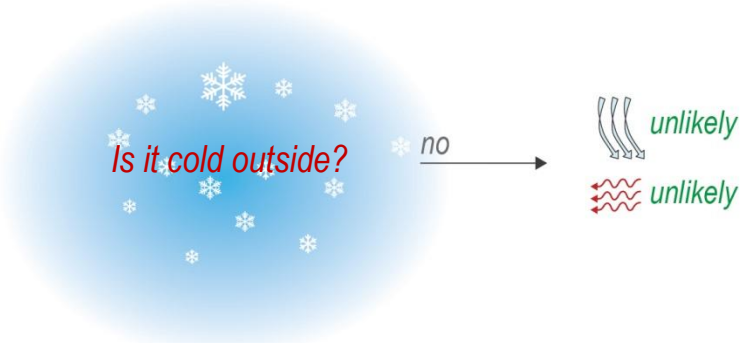
- Minimize occupant discomfort
- Typically analyzed late in the design process through CFD analysis



HOW TO SELECT THE RIGHT GLAZING?

= downdraft discomfort

= radiant discomfort



HOW TO SELECT THE RIGHT GLAZING?

= downdraft discomfort

= radiant discomfort

Is it cold outside?

no → unlikely

unlikely

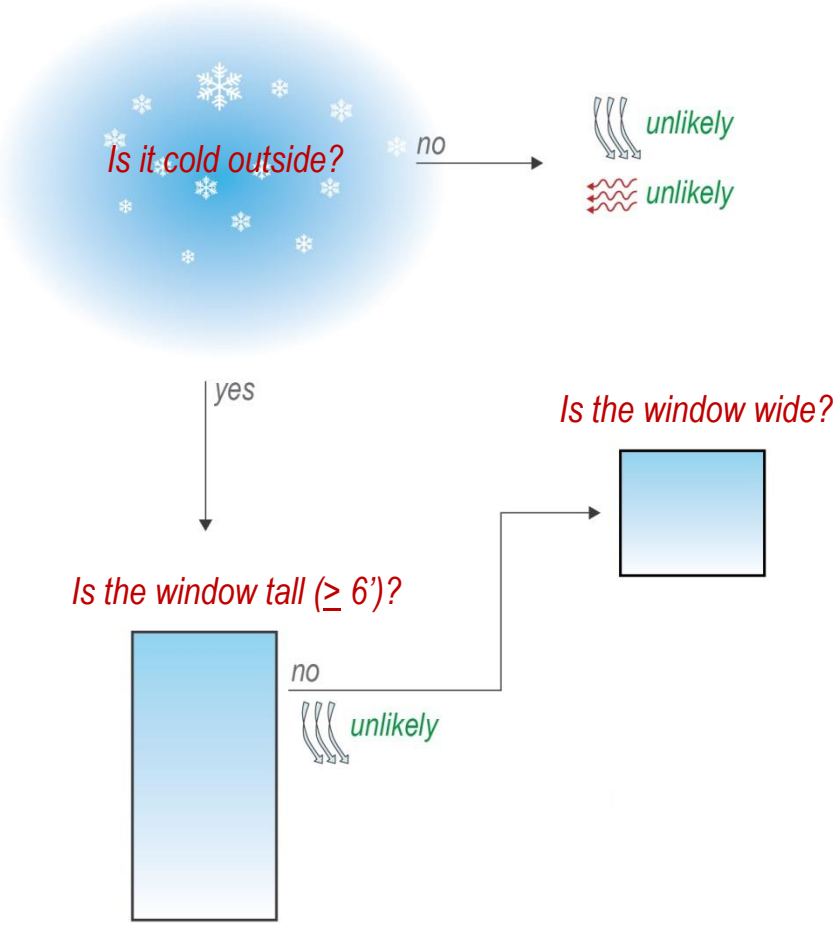
yes

Is the window tall (≥ 6')?

HOW TO SELECT THE RIGHT GLAZING?

= downdraft discomfort

= radiant discomfort



HOW TO SELECT THE RIGHT GLAZING?

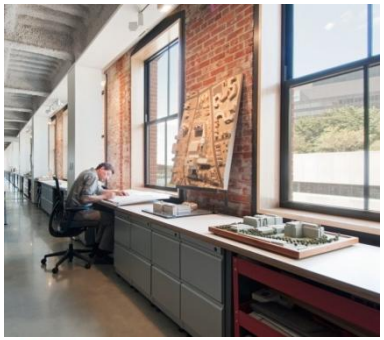
= downdraft discomfort

= radiant discomfort

Is it cold outside?

no → unlikely

unlikely



yes

Is the window wide?

unlikely

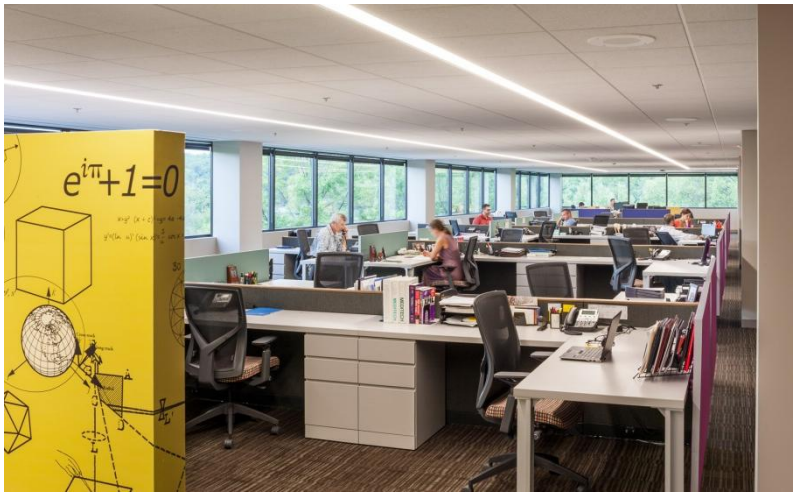
no

yes

Is the window tall (≥ 6')?

no

unlikely



HOW TO SELECT THE RIGHT GLAZING?

= downdraft discomfort

= radiant discomfort

Is it cold outside?

no → unlikely (downdraft discomfort)

unlikely (radiant discomfort)

yes

Is the window tall (≥ 6')?

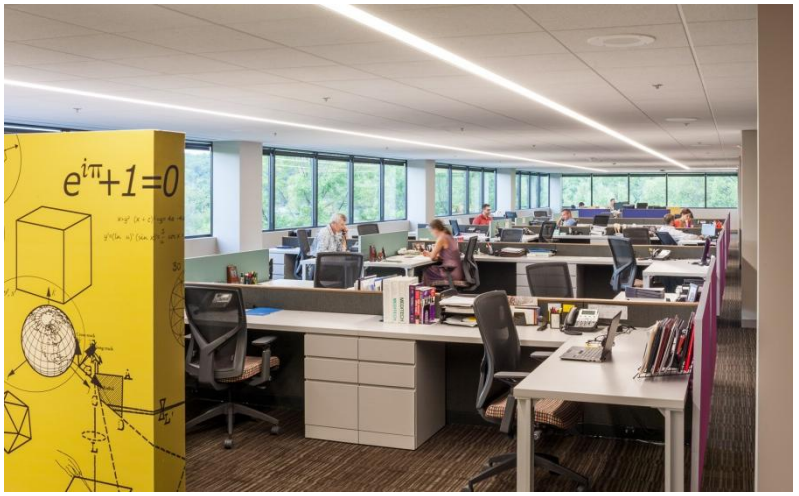
no → unlikely (downdraft discomfort)

Is the window wide?

no → unlikely (radiant discomfort)

yes

Is there a room-side low-e coating?



HOW TO SELECT THE RIGHT GLAZING?

= downdraft discomfort

= radiant discomfort

Is it cold outside?

no → unlikely (downdraft) unlikely (radiant)

yes

Is the window tall (≥ 6')?

no → unlikely (downdraft)

Is the window wide?

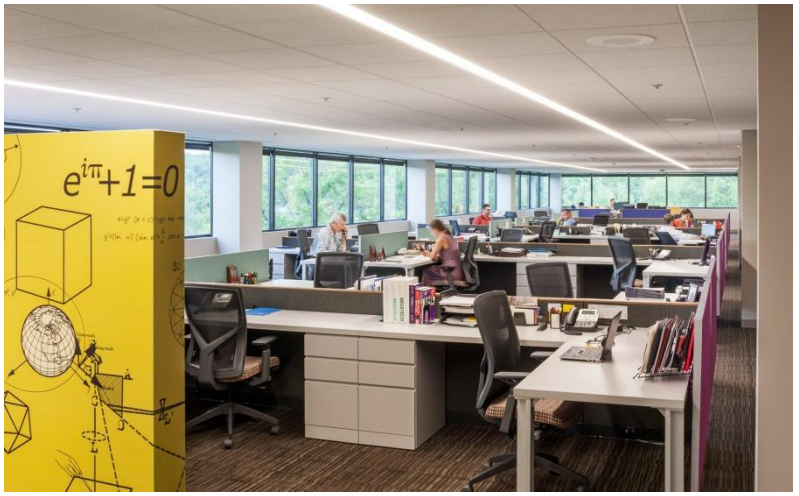
no → unlikely (radiant)

yes

Is there a room-side low-e coating?

no → likely (radiant) unlikely (downdraft)

yes → unlikely (radiant) unlikely (downdraft)



HOW TO SELECT THE RIGHT GLAZING?

= downdraft discomfort

= radiant discomfort

Is it cold outside?

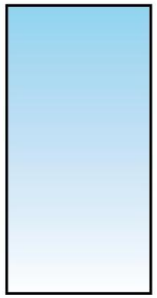
no → unlikely, unlikely

yes

Is the window tall (≥ 6')?

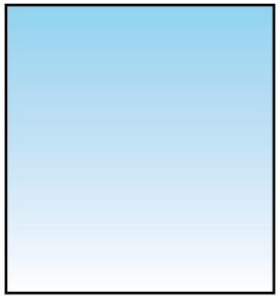
yes

Is the window wide?



yes

Is there a room-side low-e coating?



yes → likely, unlikely

no → likely, likely

HOW TO SELECT THE RIGHT GLAZING?

= downdraft discomfort

= radiant discomfort

Is it cold outside?

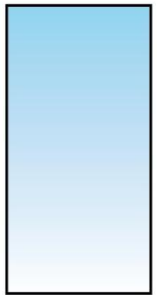
no → unlikely (downdraft discomfort) / unlikely (radiant discomfort)

yes

Is the window tall (≥ 6')?

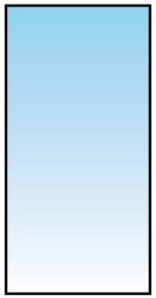
yes

Is the window wide?



no → unlikely (radiant discomfort)

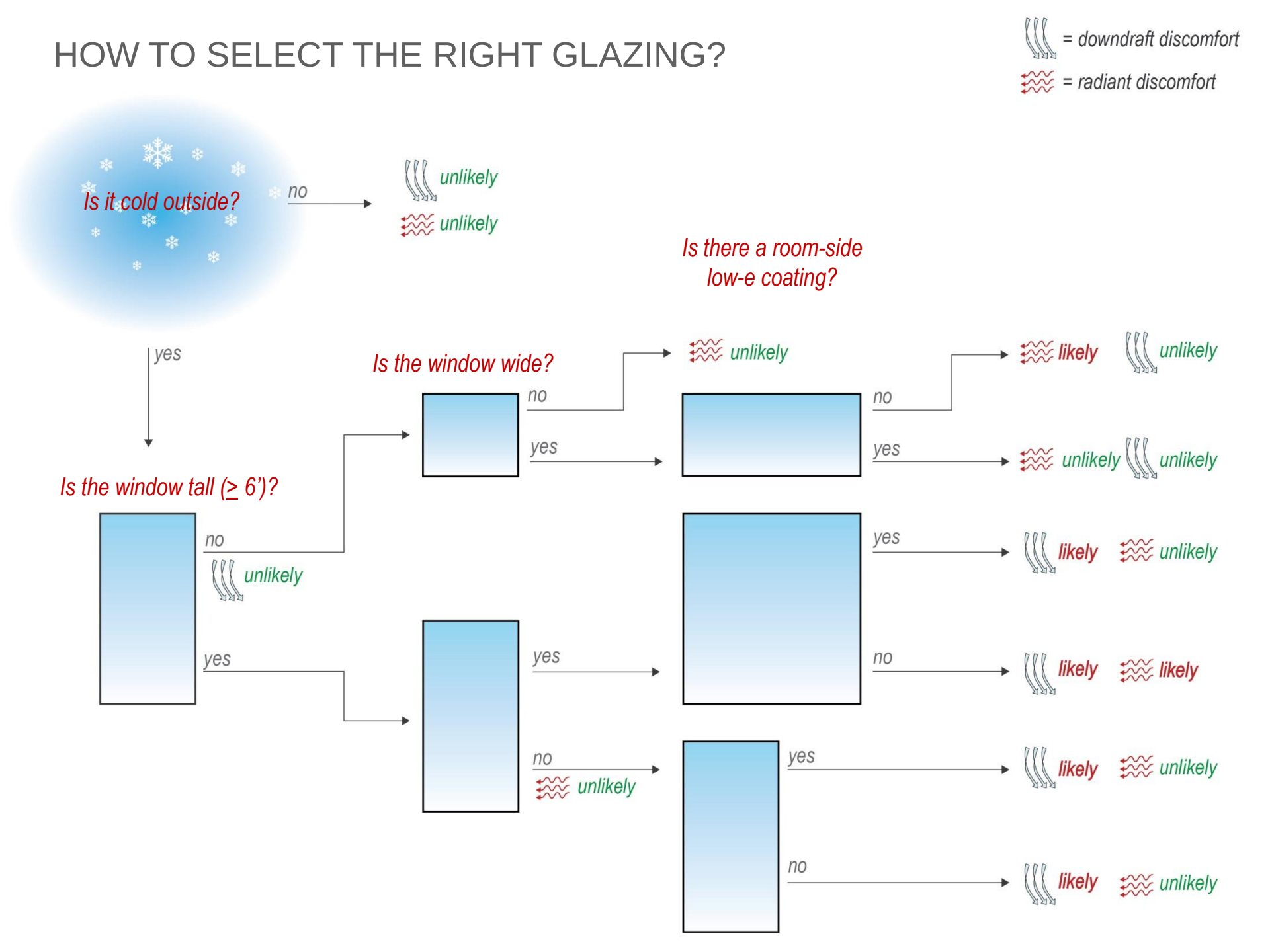
Is there a room-side low-e coating?



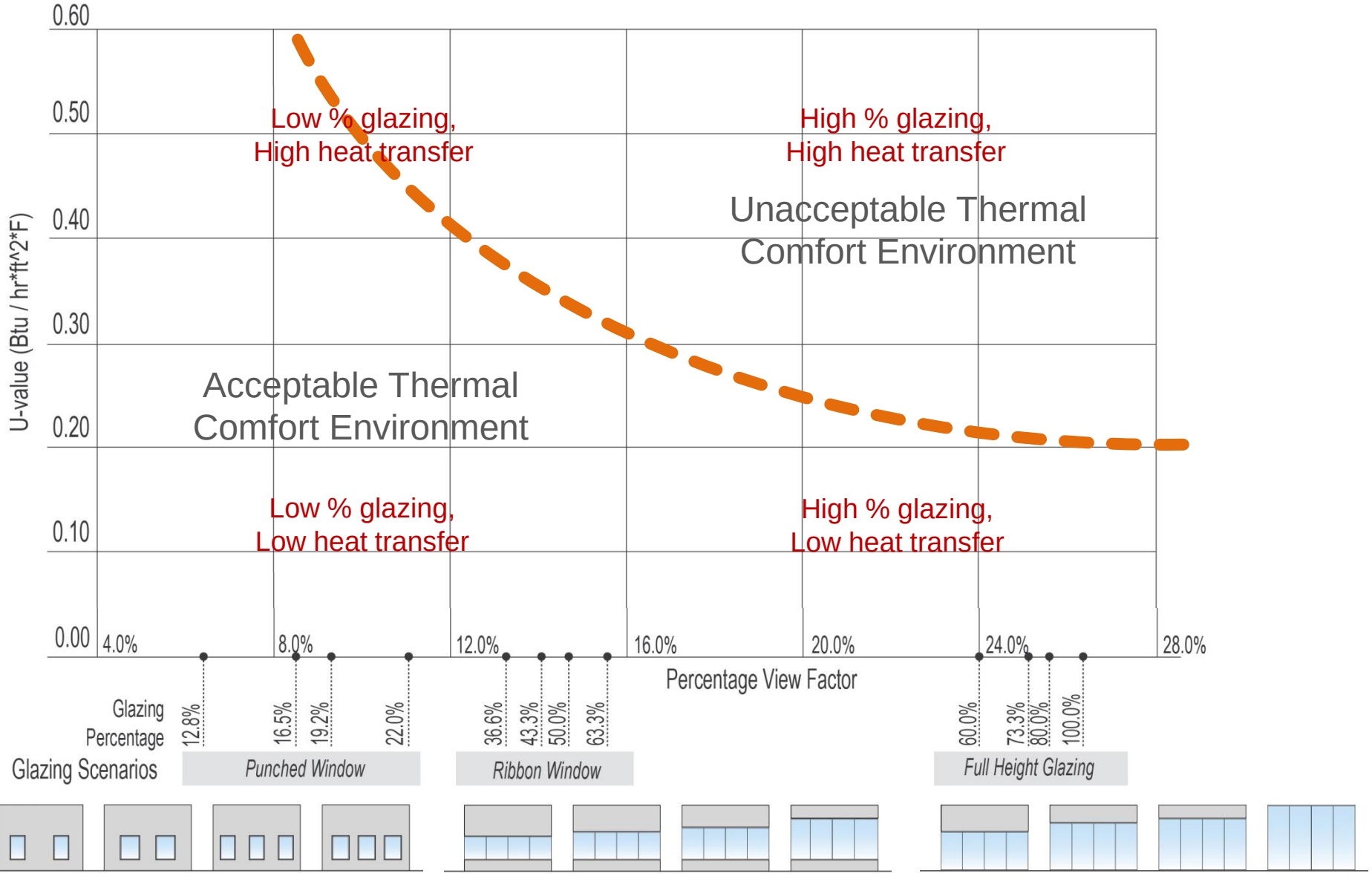
yes → likely (downdraft discomfort) / unlikely (radiant discomfort)

no → likely (downdraft discomfort) / unlikely (radiant discomfort)

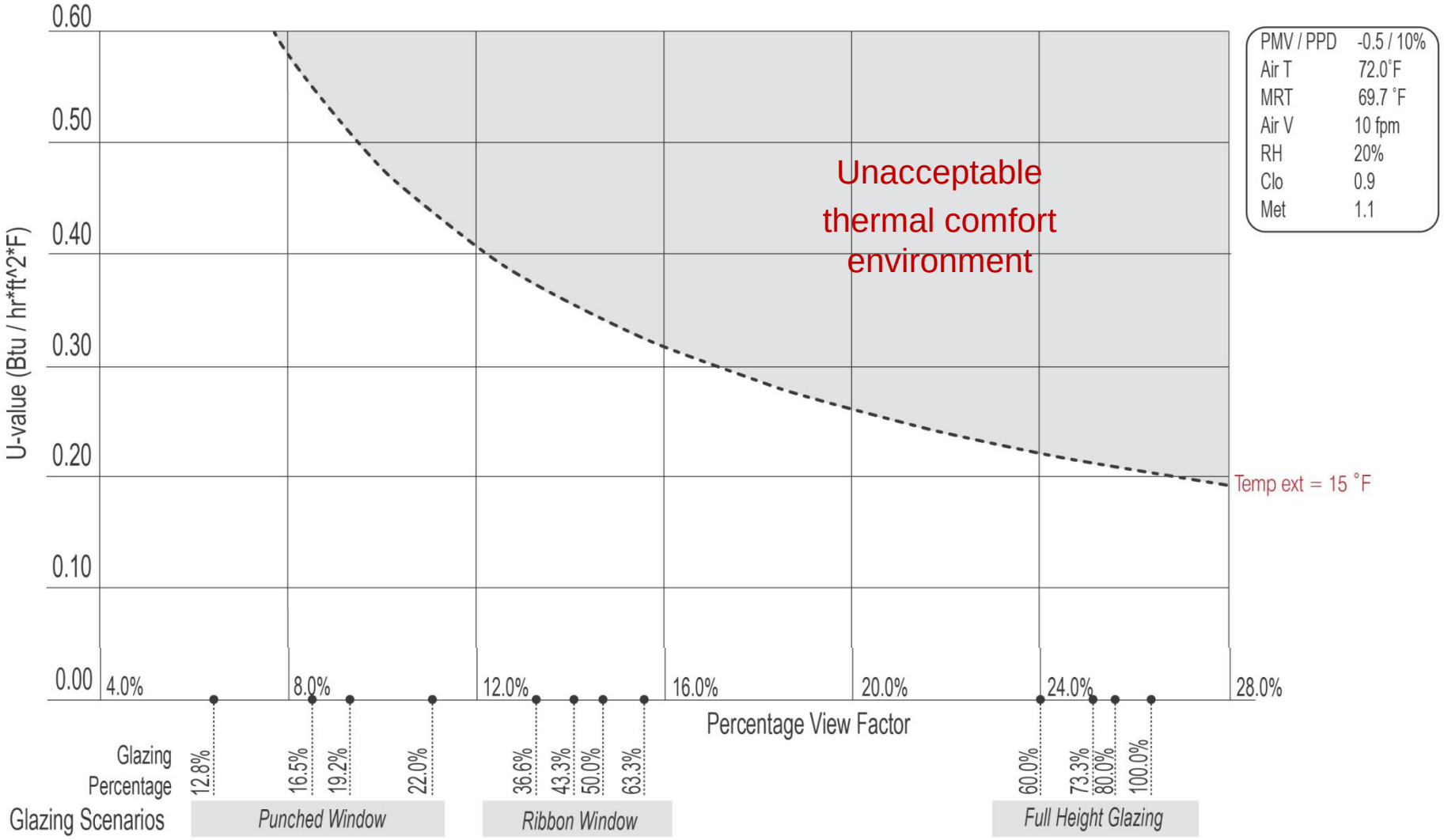
HOW TO SELECT THE RIGHT GLAZING?



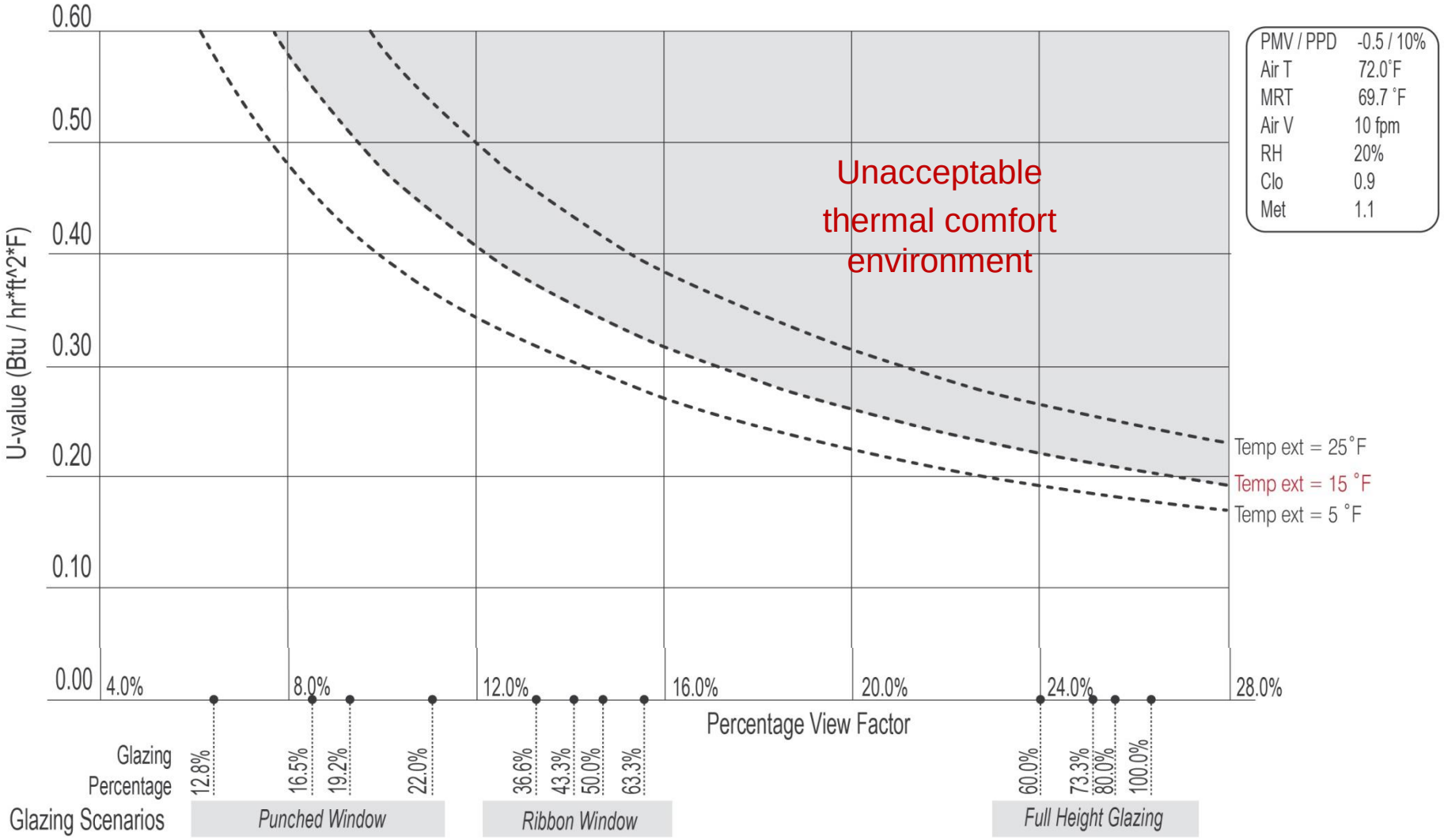
RADIANT DISCOMFORT | U-Value vs. View Factor



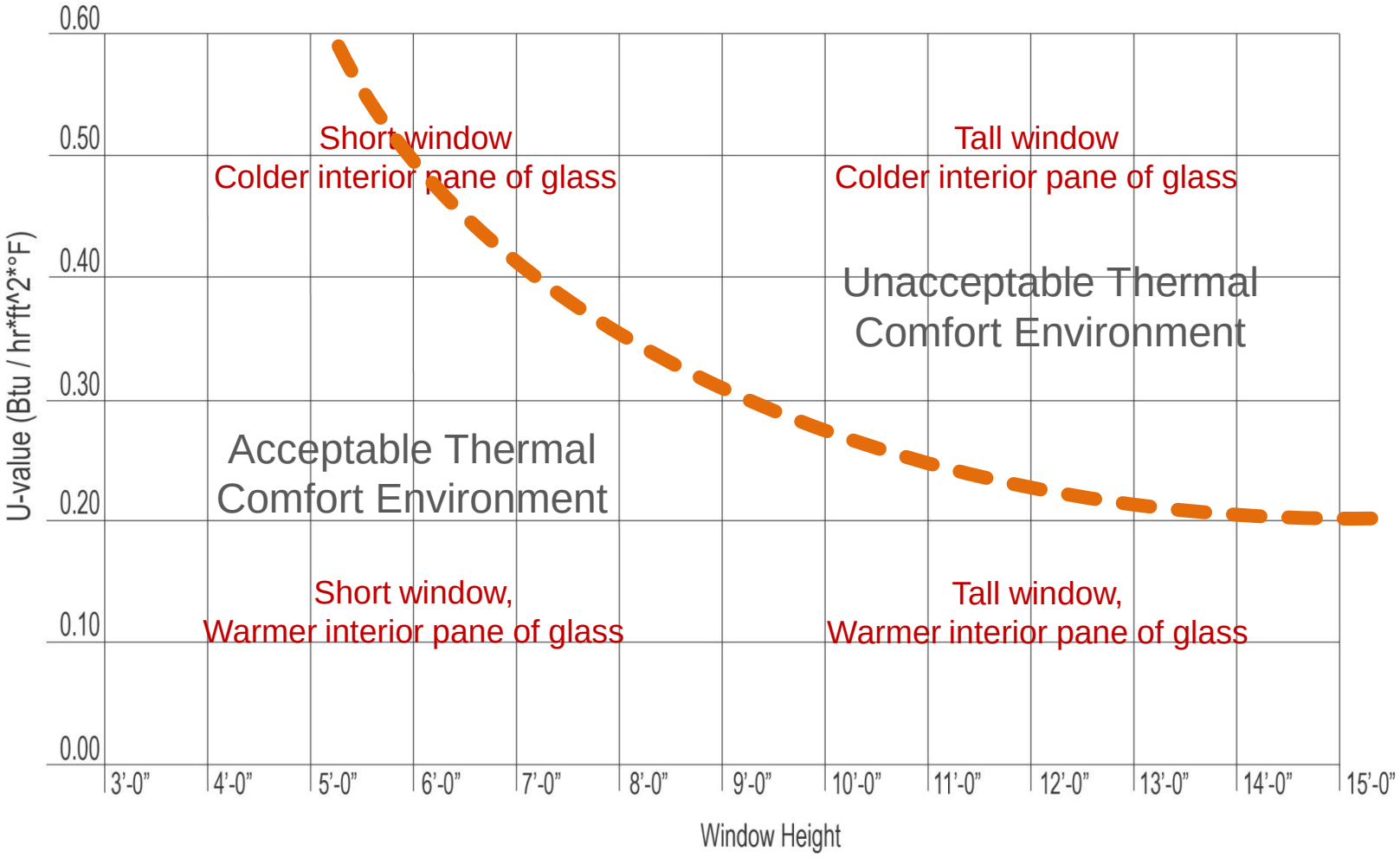
RADIANT DISCOMFORT | U-Value vs. View Factor



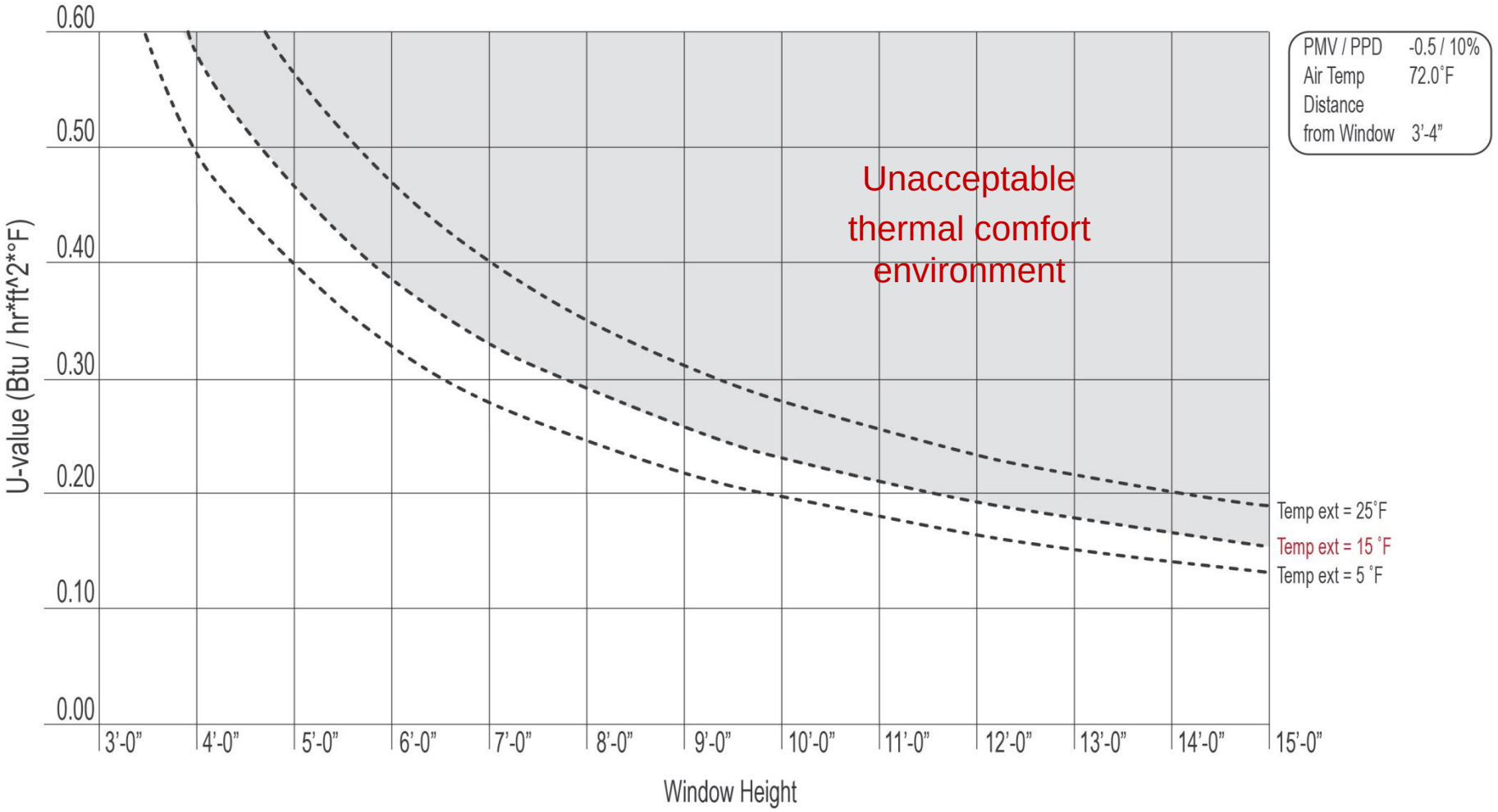
RADIANT DISCOMFORT | U-Value vs. View Factor



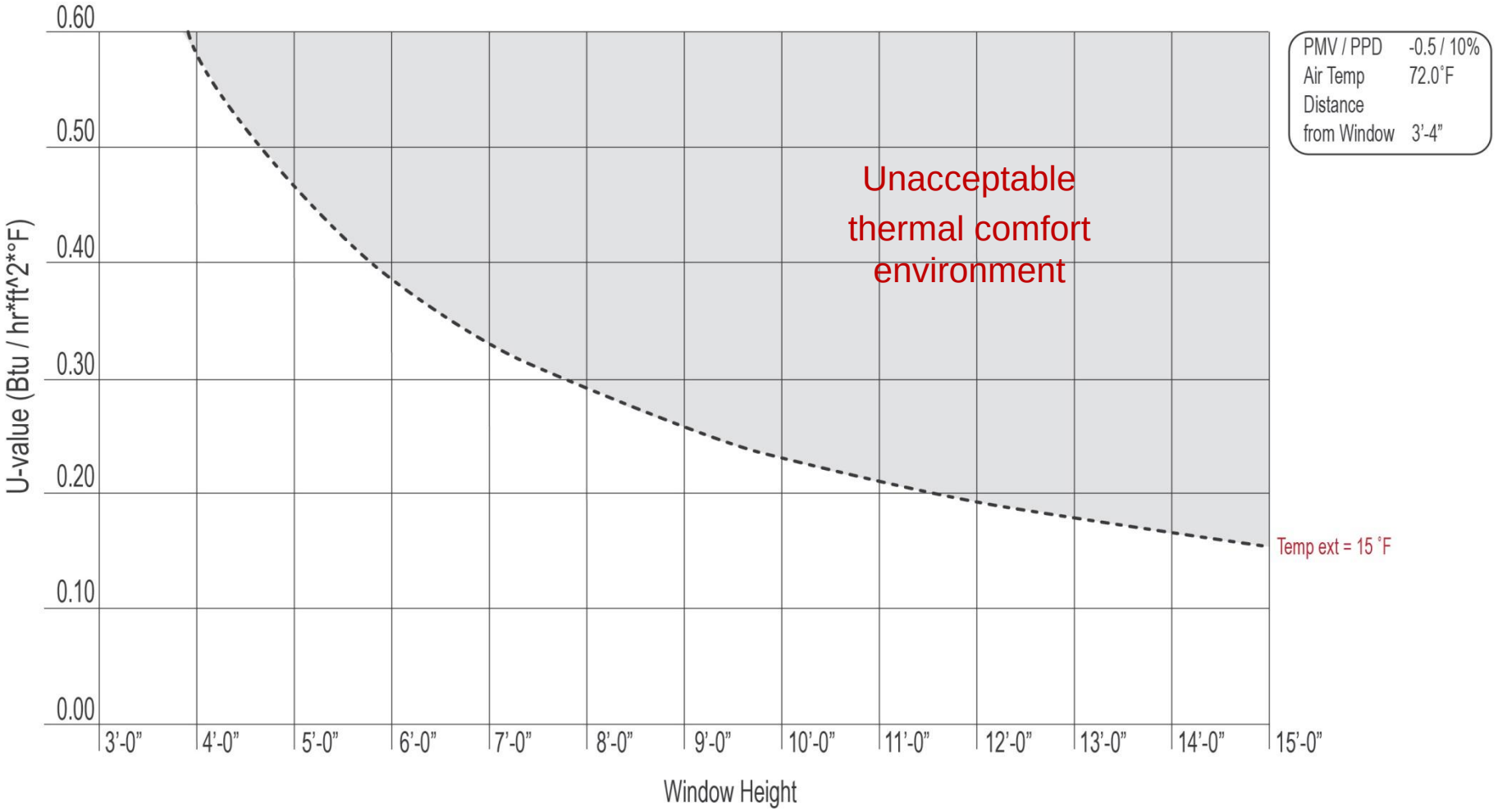
DOWNDRAFT DISCOMFORT | U-Value vs. Window Height



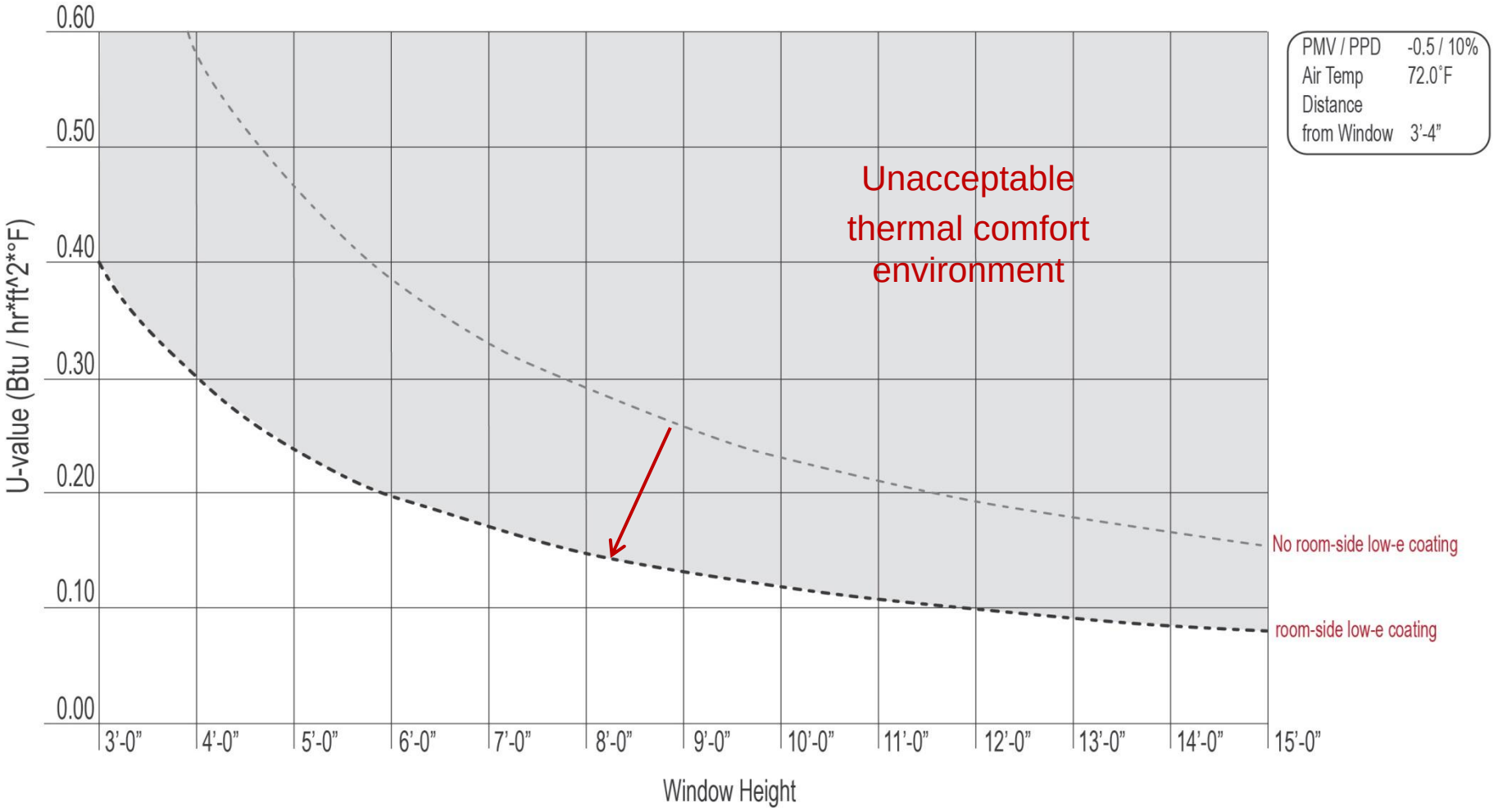
DOWNDRAFT DISCOMFORT | U-Value vs. Window Height



DOWNDRAFT DISCOMFORT | U-Value vs. Window Height



DOWNDRAFT DISCOMFORT | U-Value vs. Window Height

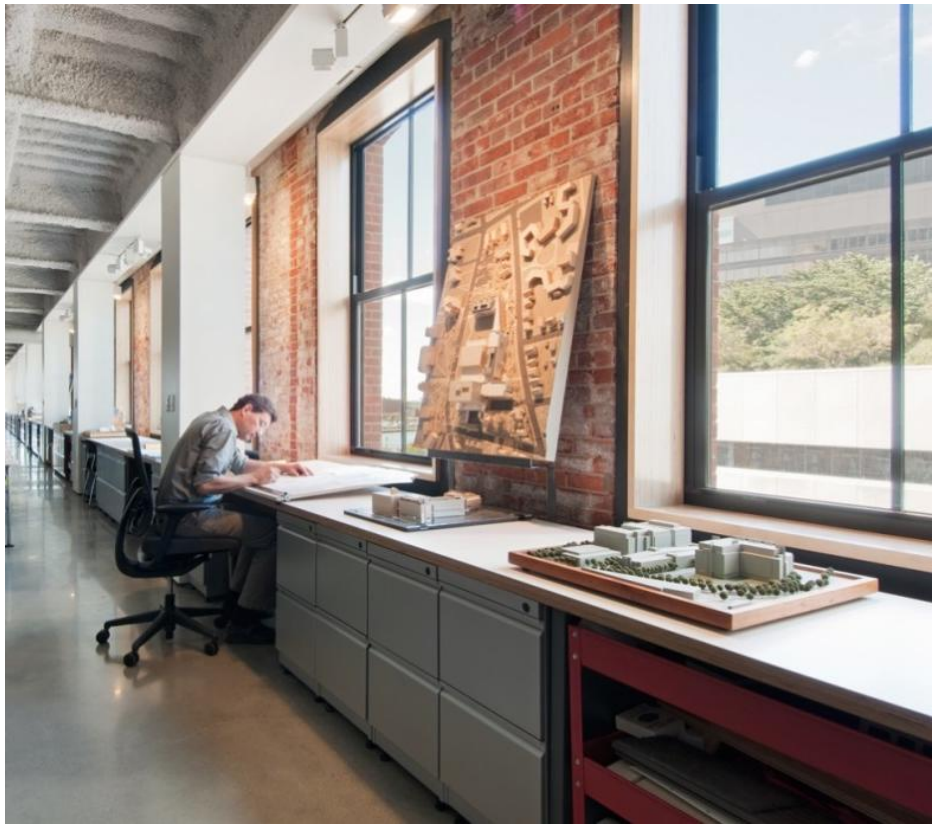


EXAMPLES | Punched Window

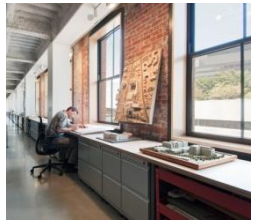
Window Dimensions:

4’ (w) x 6’ (h) with sill

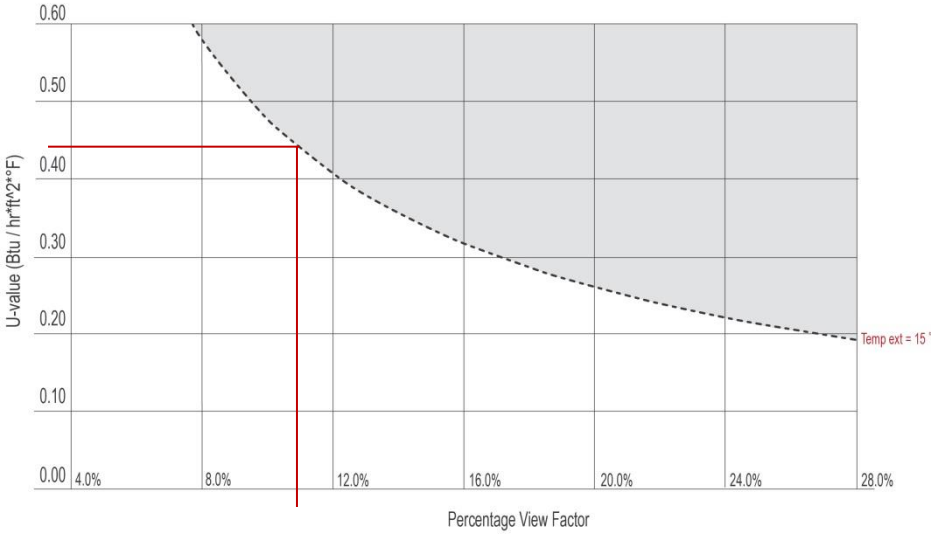
Percentage View Factor: 10.5%



EXAMPLES | Punched Window without Room-Side Low-e

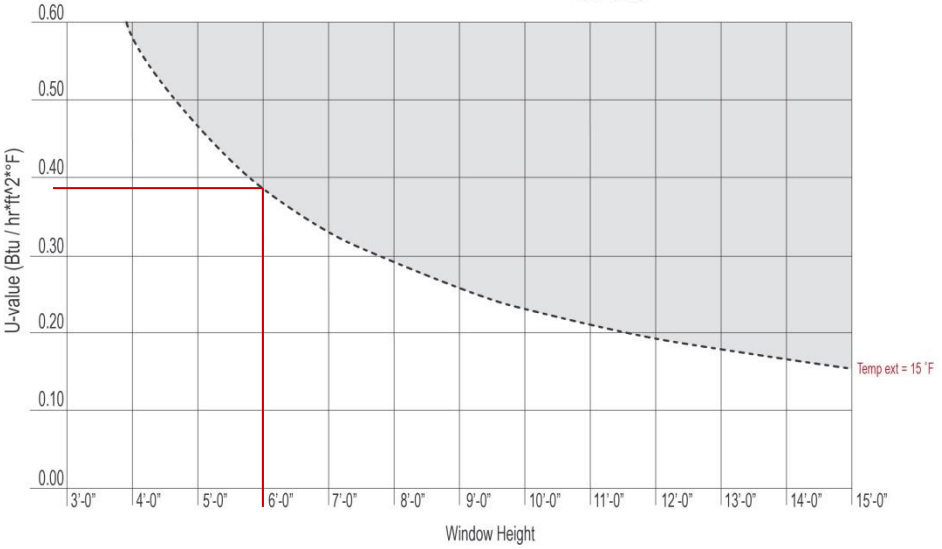


Radiant Discomfort



U-value – 0.44

Downdraft Discomfort



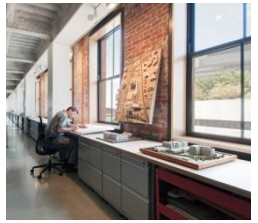
U-value – 0.38

View Factor Percentage: 10.5%

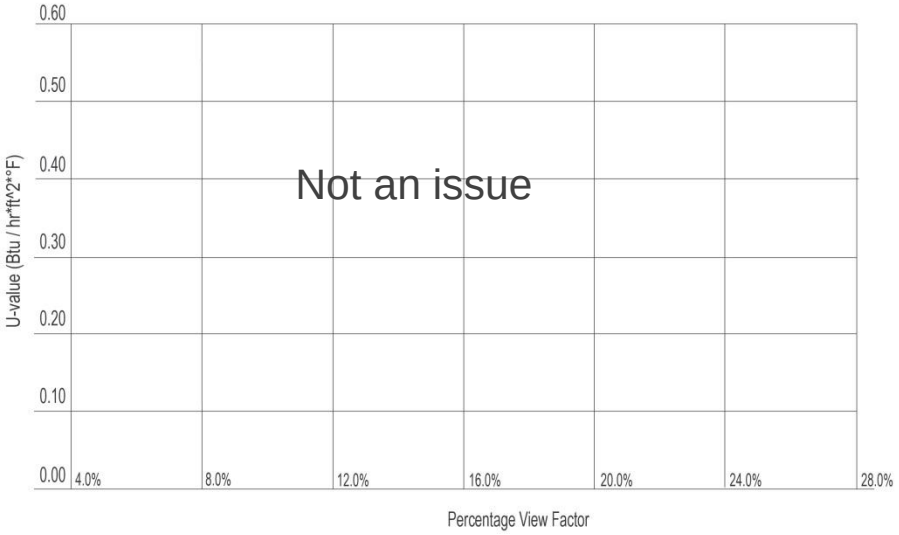
Window Height: 6’-0”

15°F exterior design temperature

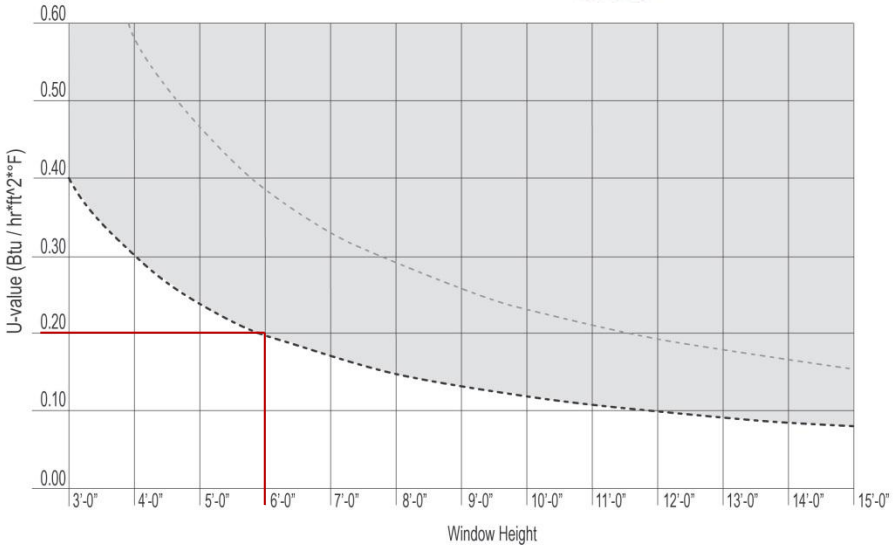
EXAMPLES | Punched Window with Room-Side Low-e



Radiant Discomfort



Downdraft Discomfort



U-value – 0.20

View Factor Percentage: 10.5%

Window Height: 6’-0”

15°F exterior design temperature

EXAMPLES | Full Height Glazing

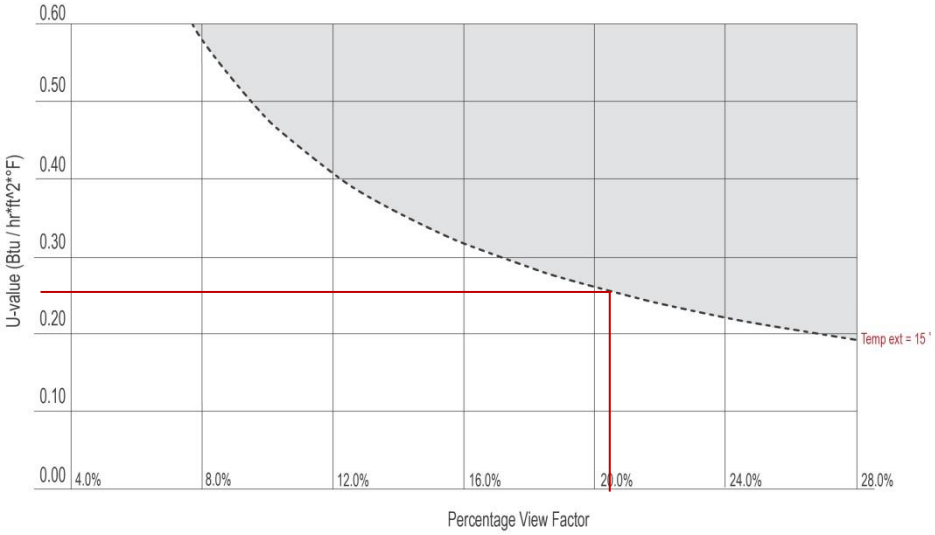
Window Dimensions:

10’ (h) x 11’ (w)

Percentage View Factor: 20.4%

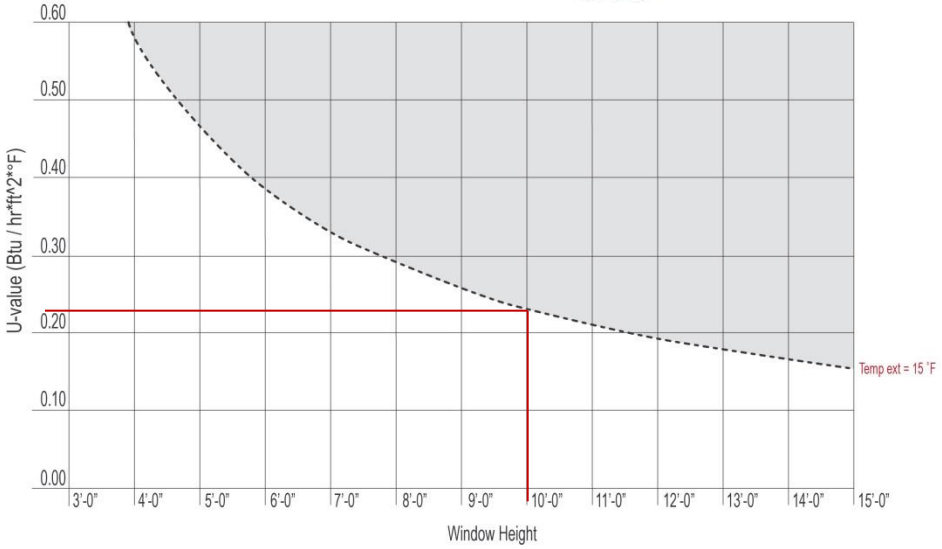
EXAMPLES | Full Height Glazing without Room-Side Low-e

Radiant Discomfort



U-value – 0.25

Downdraft Discomfort



U-value – 0.23

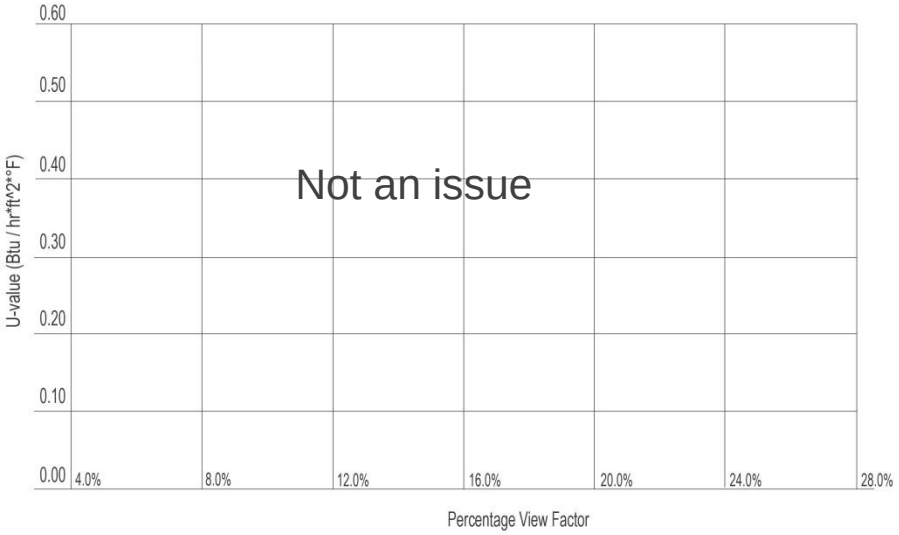
View Factor: 20.4%

Window Height: 10’-0”

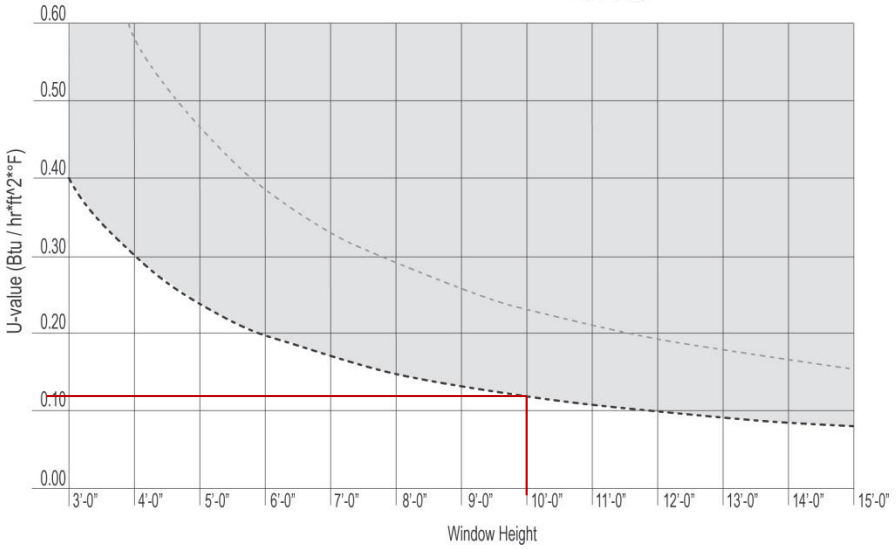
15°F exterior design temperature

EXAMPLES | Full Height Glazing with Room-Side Low-e

Radiant Discomfort



Downdraft Discomfort



U-value – 0.12

View Factor: 20.4%

Window Height: 10’-0”

15°F exterior design temperature

EXAMPLES | Tall Window

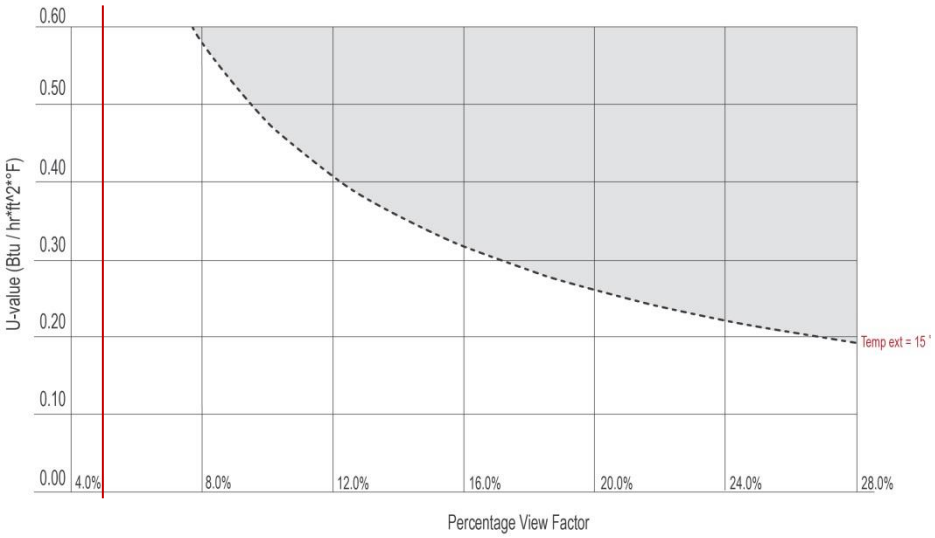
Window Dimensions:

9’ (h) with 3’ (w) no sill

Percentage View Factor: 5.0%

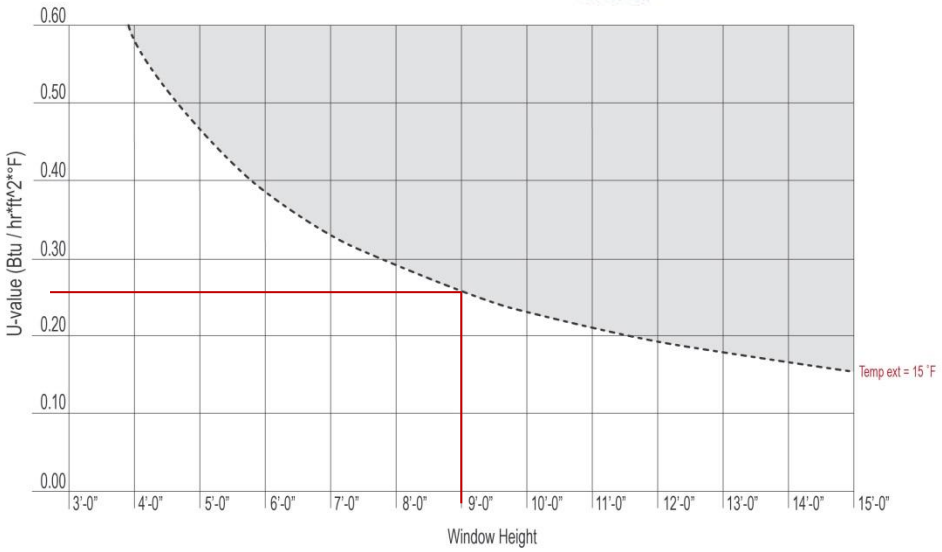
EXAMPLES | Tall Window without Room-Side Low-e

Radiant Discomfort



U-value: > 0.60

Downdraft Discomfort



U-value – 0.26

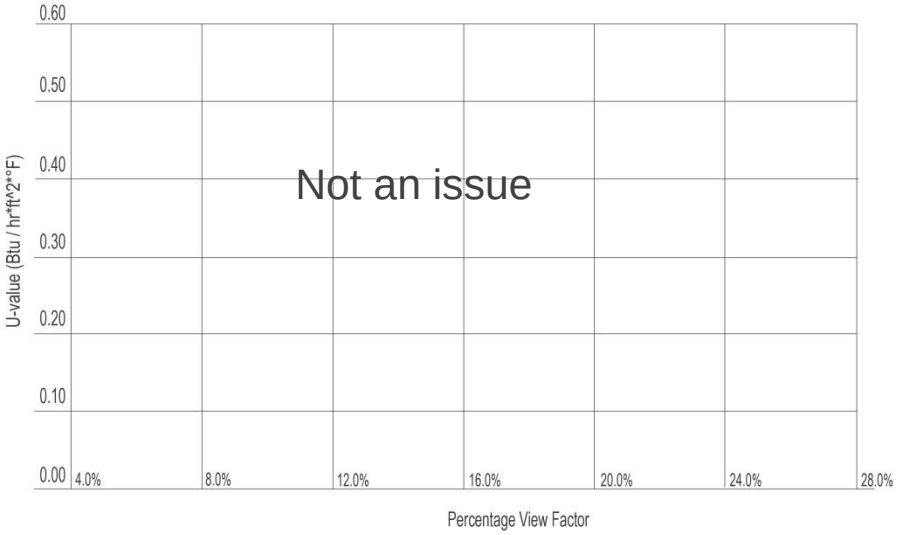
Percentage View Factor: 5.0%

Window Height: 9’-0”

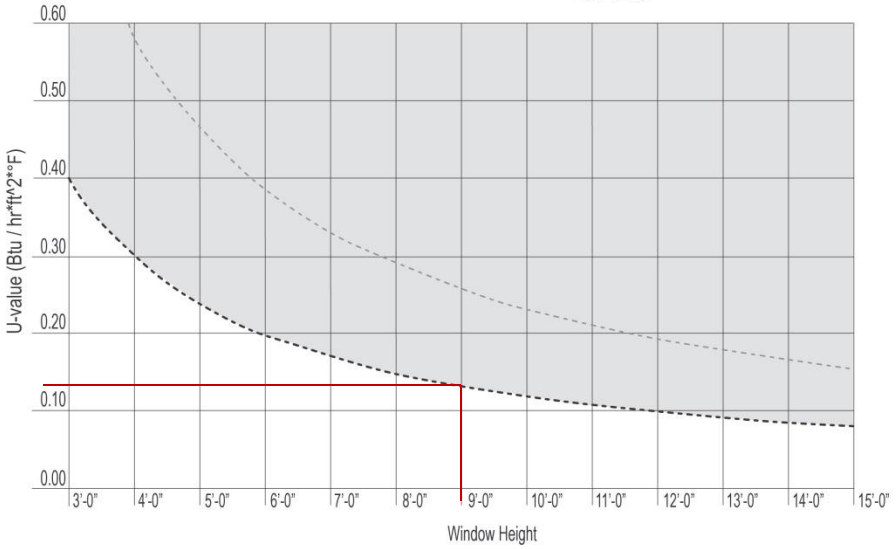
15°F exterior design temperature

EXAMPLES | Tall Window with Room-Side Low-e

Radiant Discomfort



Downdraft Discomfort



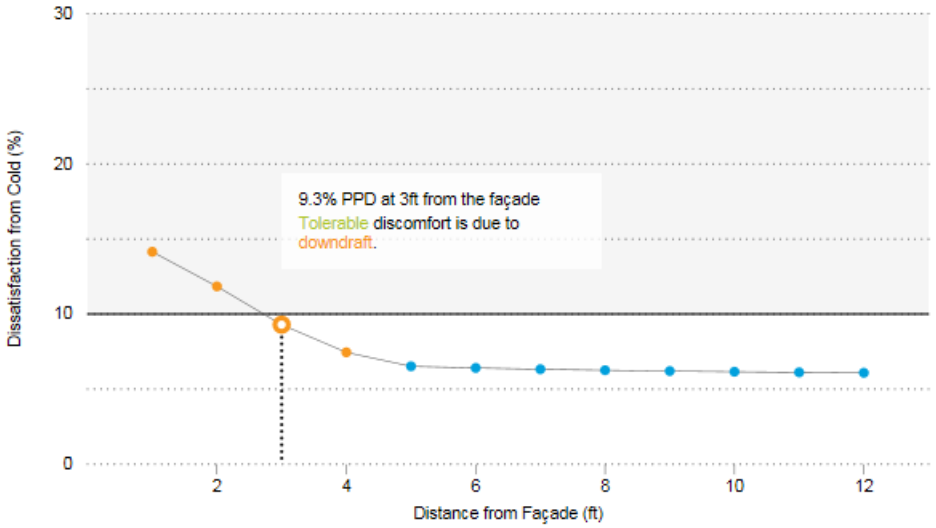
U-value: 0.13

Percentage View Factor: 5.0%

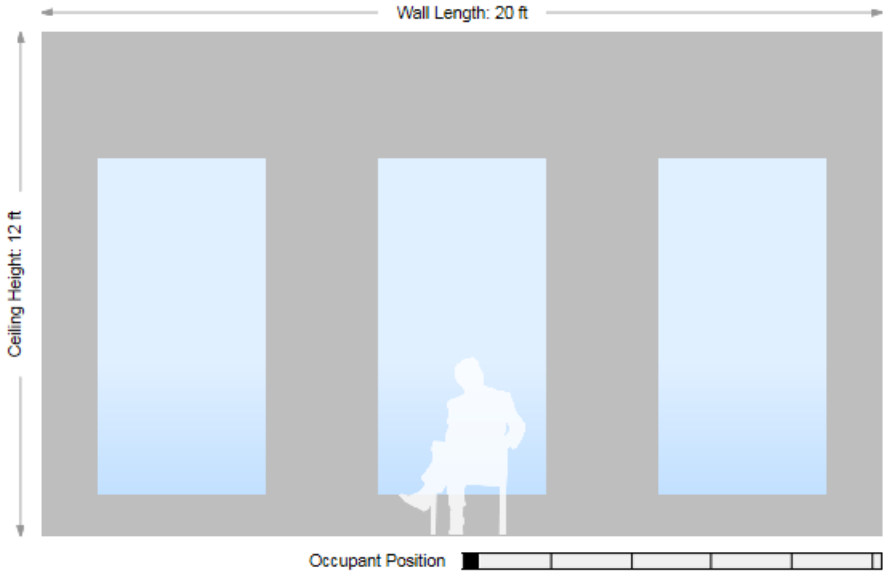
Window Height: 9’-0”

15°F exterior design temperature

GLAZING AND THERMAL COMFORT ANALYSIS TOOL



FAÇADE REPRESENTATION



Glazing and Comfort Analysis Tool

FAÇADE GEOMETRY

Ceiling Height (ft)	15
Wall Length (ft)	20
Window Height (ft)	8
Set Glazing Amount By	
☑ Window Width (ft)	4
☐ *Glazing Ratio (%)*	40
Sill Height (ft)	1
Window Separation (ft)	6.67

FACADE PERFORMANCE

Window U-Value (Btu/hr*ft²*°F)	.25
Auto-calculate U-Value	AutoCal
Room-side Low-E Coating	☐
Emissivity	
Wall R-Value (Btu/hr*ft²*°F)	20

OCCUPANCY THRESHOLDS

Dissatisfaction from Cold (%)	10
Distance From Façade (ft)	3

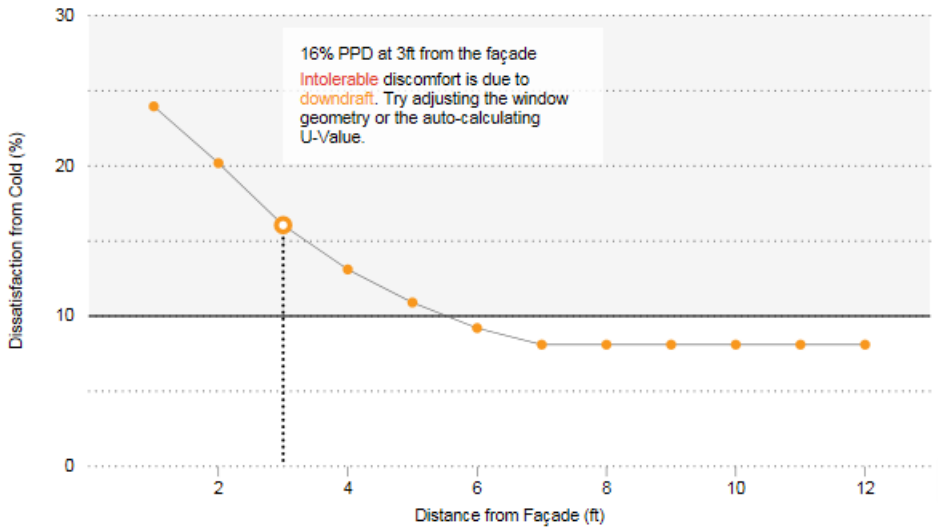
OTHER

Outdoor Temperature (°F)	15
Indoor Ambient Temperature (°F)	72
Relative Humidity (%)	20

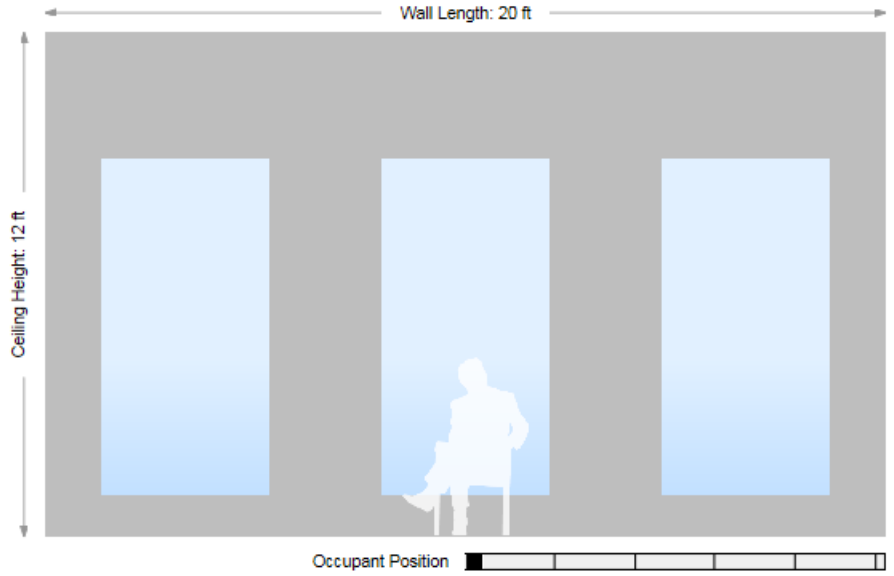
ADVANCED OPTIONS

Radiant Floor	☐
Air Speed (fpm)	10
Clothing (clo)	1
Metabolic Rate (met)	1.1

GLAZING AND THERMAL COMFORT ANALYSIS TOOL



FAÇADE REPRESENTATION



Glazing and Comfort Analysis Tool

FAÇADE GEOMETRY

Ceiling Height (ft)	15
Wall Length (ft)	20
Window Height (ft)	8
Set Glazing Amount By	
☑ Window Width (ft)	4
☐ *Glazing Ratio (%)*	40
Sill Height (ft)	1
Window Separation (ft)	6.67

FACADE PERFORMANCE

Window U-Value (Btu/hr*ft²*°F)	.25
Auto-calculate U-Value	AutoCal
Room-side Low-E Coating	☑
Emissivity	0.2
Wall R-Value (Btu/hr*ft²*°F)	20

OCCUPANCY THRESHOLDS

Dissatisfaction from Cold (%)	10
Distance From Façade (ft)	3

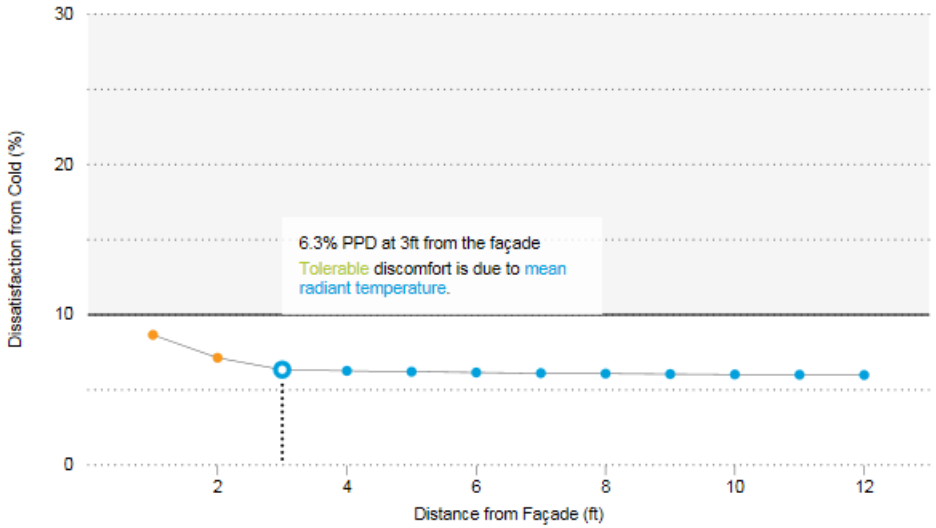
OTHER

Outdoor Temperature (°F)	15
Indoor Ambient Temperature (°F)	72
Relative Humidity (%)	20

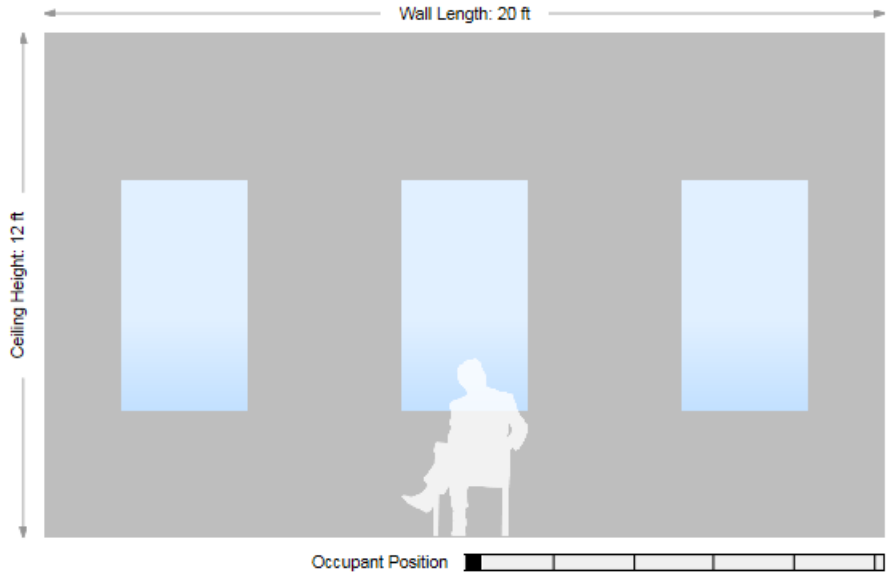
ADVANCED OPTIONS

Radiant Floor	☐
Air Speed (fpm)	10
Clothing (clo)	1
Metabolic Rate (met)	1.1

GLAZING AND THERMAL COMFORT ANALYSIS TOOL



FAÇADE REPRESENTATION



Glazing and Comfort Analysis Tool

FAÇADE GEOMETRY

Ceiling Height (ft)	15
Wall Length (ft)	20
Window Height (ft)	5.5
Set Glazing Amount By	
☑ Window Width (ft)	3
☐ *Glazing Ratio (%)*	21
Sill Height (ft)	3
Window Separation (ft)	6.67

FACADE PERFORMANCE

Window U-Value (Btu/hr*ft²*°F)	.20
Auto-calculate U-Value	AutoCal
Room-side Low-E Coating	☐
Emissivity	
Wall R-Value (Btu/hr*ft²*°F)	20

OCCUPANCY THRESHOLDS

Dissatisfaction from Cold (%)	10
Distance From Façade (ft)	3

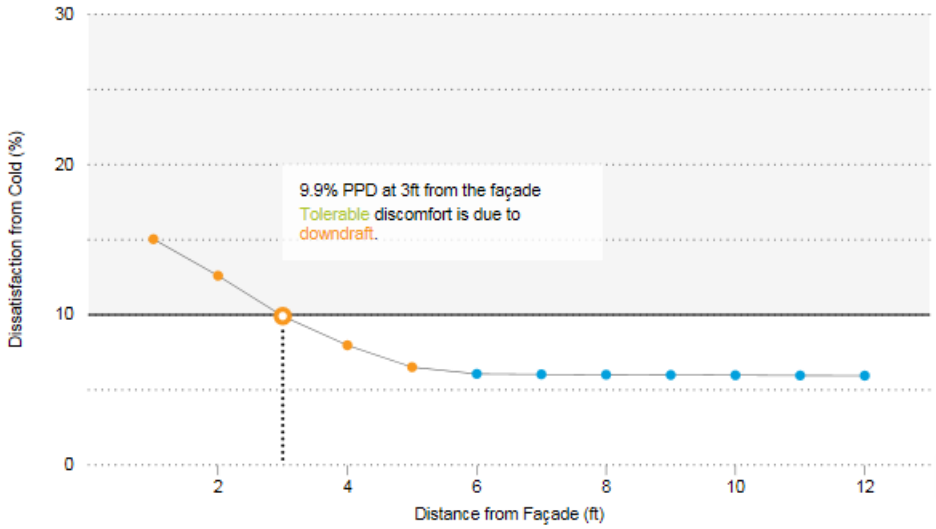
OTHER

Outdoor Temperature (°F)	15
Indoor Ambient Temperature (°F)	72
Relative Humidity (%)	20

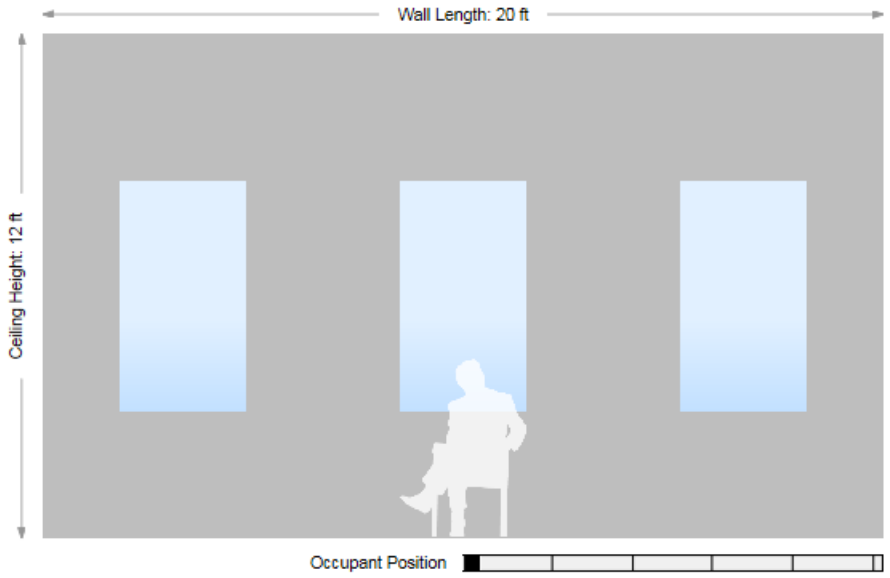
ADVANCED OPTIONS

Radiant Floor	☐
Air Speed (fpm)	10
Clothing (clo)	1
Metabolic Rate (met)	1.1

GLAZING AND THERMAL COMFORT ANALYSIS TOOL



FAÇADE REPRESENTATION



Glazing and Comfort Analysis Tool

FAÇADE GEOMETRY

Ceiling Height (ft)	15
Wall Length (ft)	20
Window Height (ft)	5.5
Set Glazing Amount By	
☑ Window Width (ft)	3
☐ *Glazing Ratio (%)*	21
Sill Height (ft)	3
Window Separation (ft)	6.67

FACADE PERFORMANCE

Window U-Value (Btu/hr*ft²*°F)	.20
Auto-calculate U-Value	AutoCal
Room-side Low-E Coating	☑
Emissivity	0.2
Wall R-Value (Btu/hr*ft²*°F)	20

OCCUPANCY THRESHOLDS

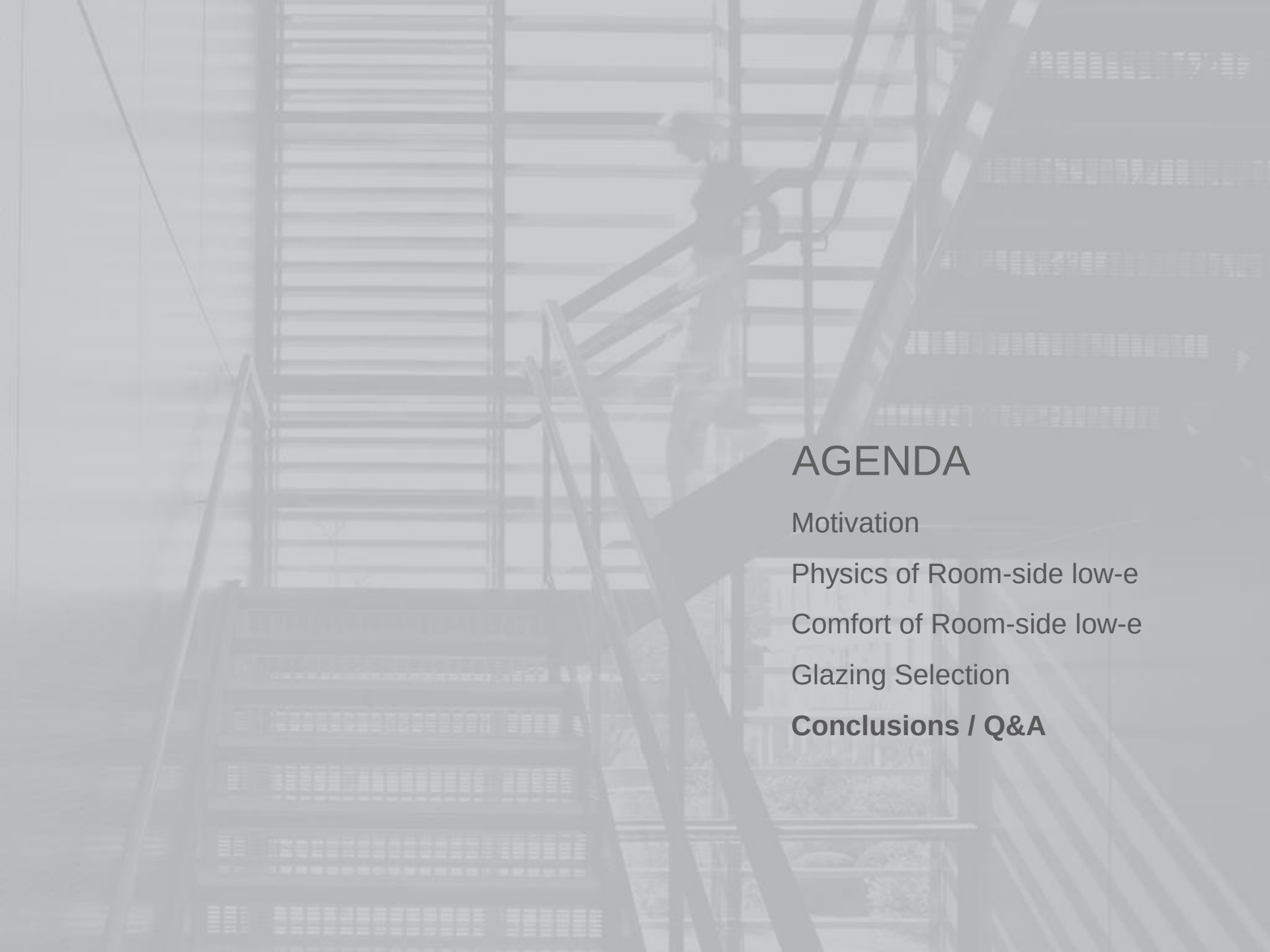
Dissatisfaction from Cold (%)	10
Distance From Façade (ft)	3

OTHER

Outdoor Temperature (°F)	15
Indoor Ambient Temperature (°F)	72
Relative Humidity (%)	20

ADVANCED OPTIONS

Radiant Floor	☐
Air Speed (fpm)	10
Clothing (clo)	1
Metabolic Rate (met)	1.1



AGENDA

Motivation

Physics of Room-side low-e

Comfort of Room-side low-e

Glazing Selection

Conclusions / Q&A

CONCLUSIONS | Room-side Low-e, As Good as it Sounds?

It depends!

Double pane IGU with room-side low-e:

- ✓ Great thermal performance
- ✓ Improved radiant thermal comfort
- ✓ Lighter, cheaper than triple pane
- ✗ Potential for downdraft discomfort with tall windows
- ✗ Potential for condensation

- Stay tuned for our new online glazing analysis tool coming soon!

More on condensation:

Using 4th Surface Low-e Coating on Windows in a Cold Climate: Background, Observations and Practical Strategies. White paper by Wright, J.L. (2012), University of Waterloo.

Room-side Low-e Coating: As Good As It Sounds?

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