lighting design lab

Envelope Issues in 2021 WA & Seattle Commercial Energy Codes

Presented by
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January 23, 2025

Seattle City Light

What Is This “Lighting Design Lab”?

- Seattle City Light's go-to resource for lighting and lighting controls since 1989 – 30+ years
- Formed by BPA and NW utilities to fill education needs for the transforming market
- Now expanded to include resources that support whole buildings
- Being rebranded!

Upcoming Events

Course	Day	Time
Save On Refrigeration – How to Optimize Commercial and Industrial Refrigeration	Tue Jan 28	8:30-10:30 a.m.
Lighting & Electrical Issues in 2021 WA & Seattle Commercial Energy Codes	Thu Feb 20	10:00-11:30 a.m.
Lessons Learned on Commercial Hot Water Heat Pump Installations	Thu Feb 27	10:00-11:00 a.m.
Our Friends: Smart Buildings Center, UW IDL, Comfort Ready Home	Thu Mar 11	10:00-11:30 a.m.
HVAC Issues in 2021 WA & Seattle Commercial Energy Codes	Thu Mar 20	10:00-11:30 a.m.
Water Heating Issues in 2021 WA & Seattle Commercial Energy Codes	Thu April 17	10:00-11:30 a.m.
Alternations Issues in 2021 WA & Seattle Commercial Energy Codes	Thu May 15	10:00-11:30 a.m.

Registration Open Soon

Event	Day	Time
Seattle City Light Trade Ally Office Hours	Fri Feb 21	9:00 a.m.

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The 2021 Energy Code
Envelope

Seattle City Light

Lighting Design Lab

January 2025

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2021 Seattle Energy Code

Today: for "Commercial Buildings" – *not* single-family or townhouse

For permits applications beginning:

- WA March 15, 2024
- Seattle November 15 2024
- "Commercial buildings" now includes low-rise (1 – 3 story) multifamily

Quick overview, Section C402 – Envelope

Misc

- C402.1 General
  - Low-energy, Semi-heated definitions
  - Greenhouse, Equipment

Qpaque envelope

- Table C402.1.3 – R-values
  - Continuous insulation
  - How to add R-values
- Table C402.1.4 – U-factors
- C402.1.5 Component performance
- C402.2 Specific components
  - Roof, wall, floor, slab on grade
  - Airspaces, cantilevered slabs

Fenestration

- Table C402.4 Fenestration
  - C402.4.1 Max glazing area
  - High-perf glazing
  - C402. 4.2 Skylights: Min & max
- C402.4 Doors

Leakage

- C402.5 Air leakage
  - Testing for dwelling units
- C402.5.9 Vestibules
- C402.5.11 Large openings interlock with HVAC

It's not *whether* to do this, it's *what's the best way*

Washington state:
70% less building energy use by 2030

- Zero-carbon buildings

Washington state:
45% reduction in GHG emissions by 2030

- 95% reduction by 2050

Seattle: Carbon-neutral buildings & vehicles by 2050

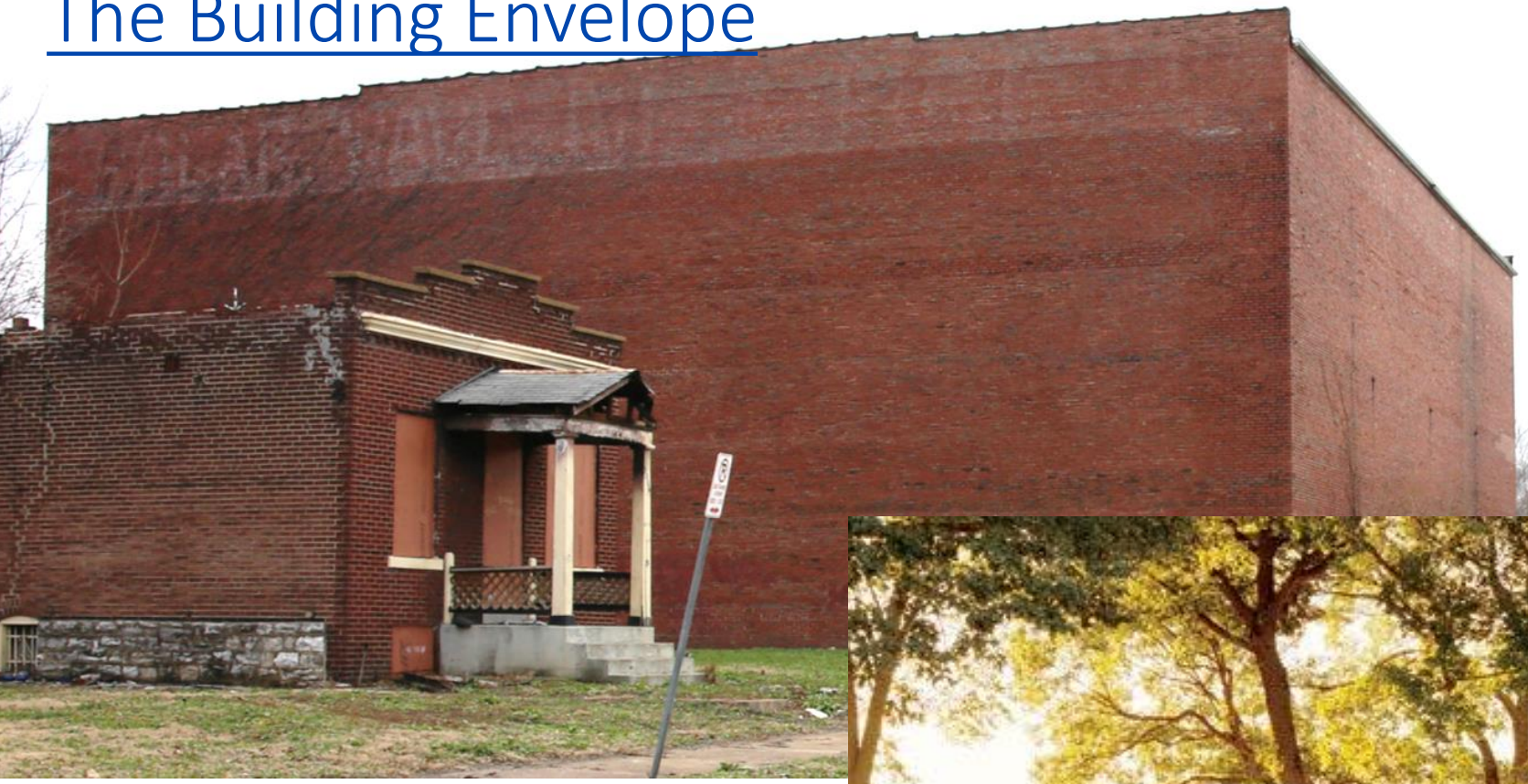
- …sooner with Seattle "Building Emissions Performance Stds"

Carbon-neutral Seattle by 2050 (or sooner)

1. Build great envelope
   - Dependable energy savings for decades
2. Eliminate combustion
   - Carbon neutral today, won't need change later
3. Use electricity wisely
   - Don't waste on electric resistance heat
4. Generate power
   - Plus "solar readiness" for bigger future system

Build now so that no "major surgery" for buildings is required for 2050

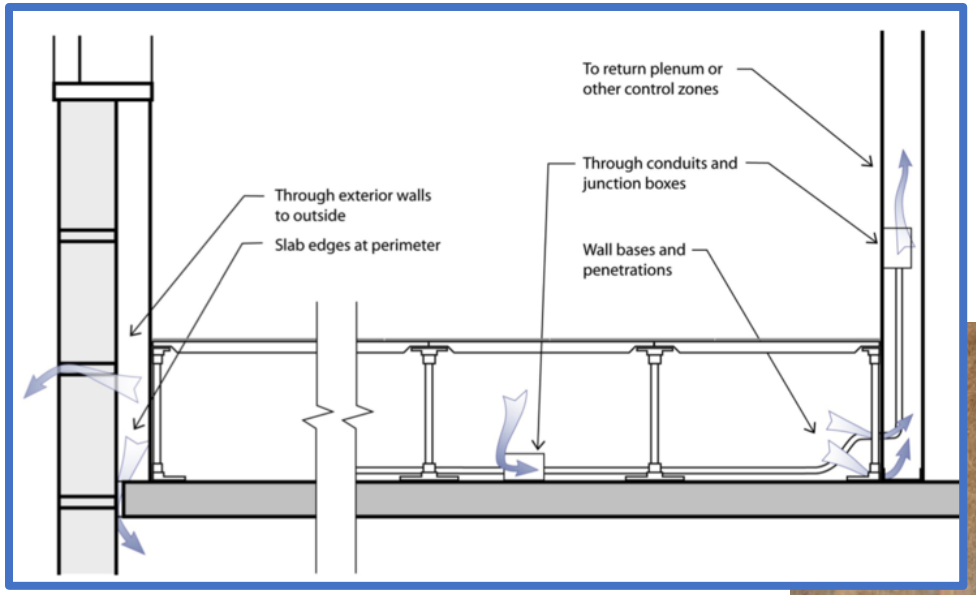
The Building Envelope

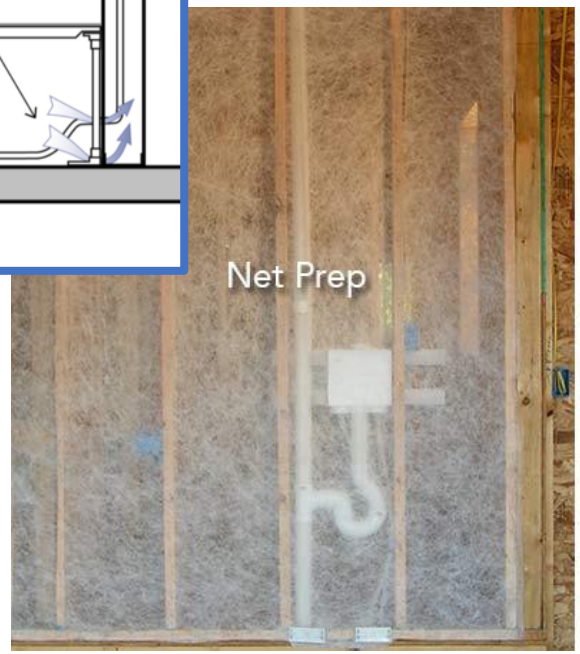


Separation…

…or Connection?

Envelope performance is boring – and effective





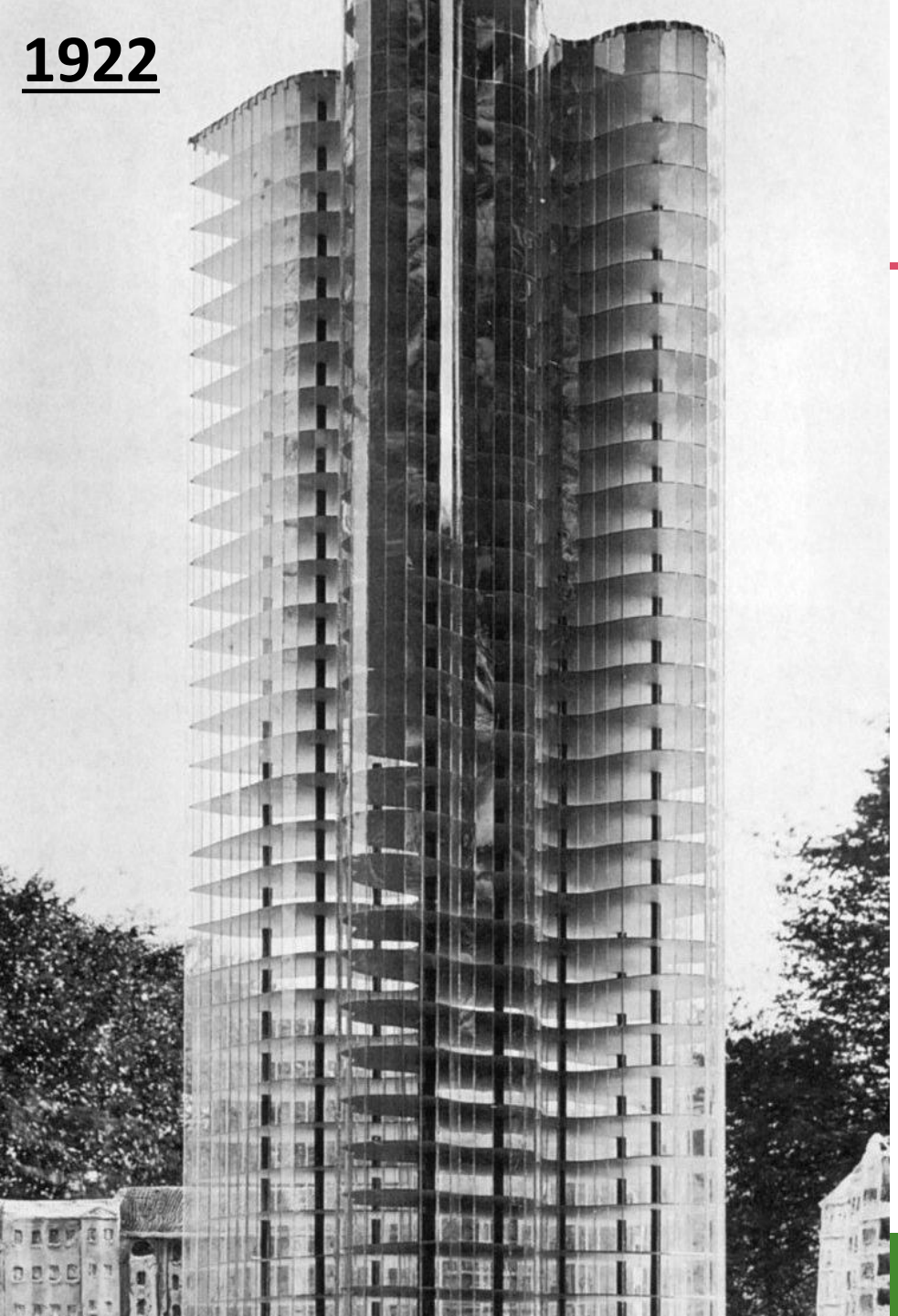
- Reliable energy savings
- Lasts for generations
- …but invisible, and dull

But it’s mostly about glazing

- **Heat loss in winter**
- **Solar gain in summer**

Also:

+ Conduction through assemblies
+ Thermal bridges
+ Air leakage through gaps & joints
+ Beneficial solar heat in winter



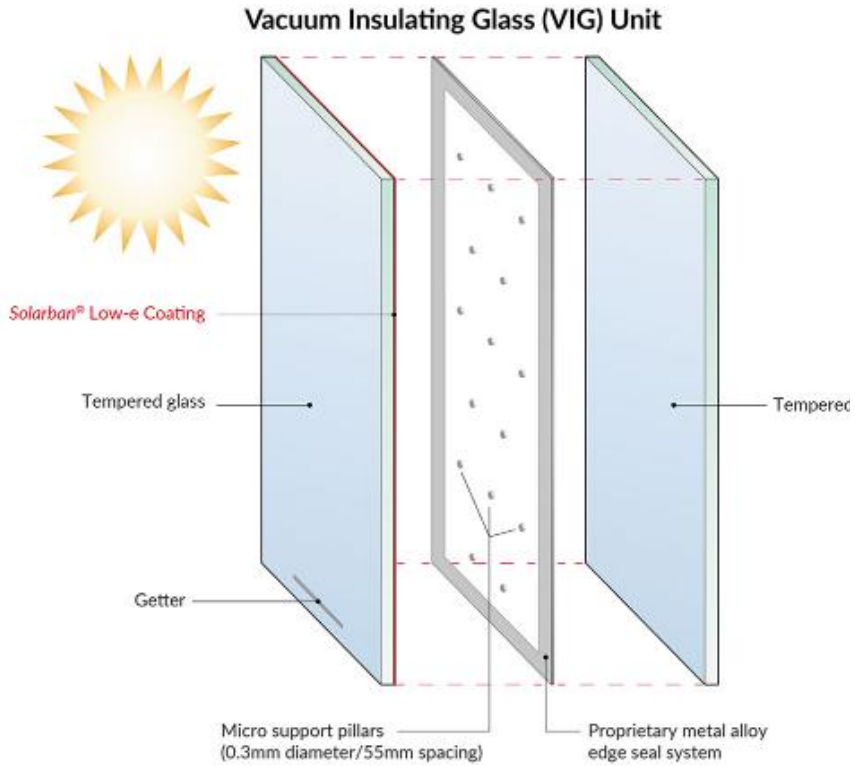
How much glass?

100 years later, we're still building all-glass towers

The other side of the coin!!!

- Poor schleps like me sit in these offices all day long and longingly look out the window
- Windows provide daylight
- Windows provide a connection to nature
- However, windows conduct 7 times more heat out of your building than solid wall
  - Not to mention leakage around the frames

Vacuum insulated glazing



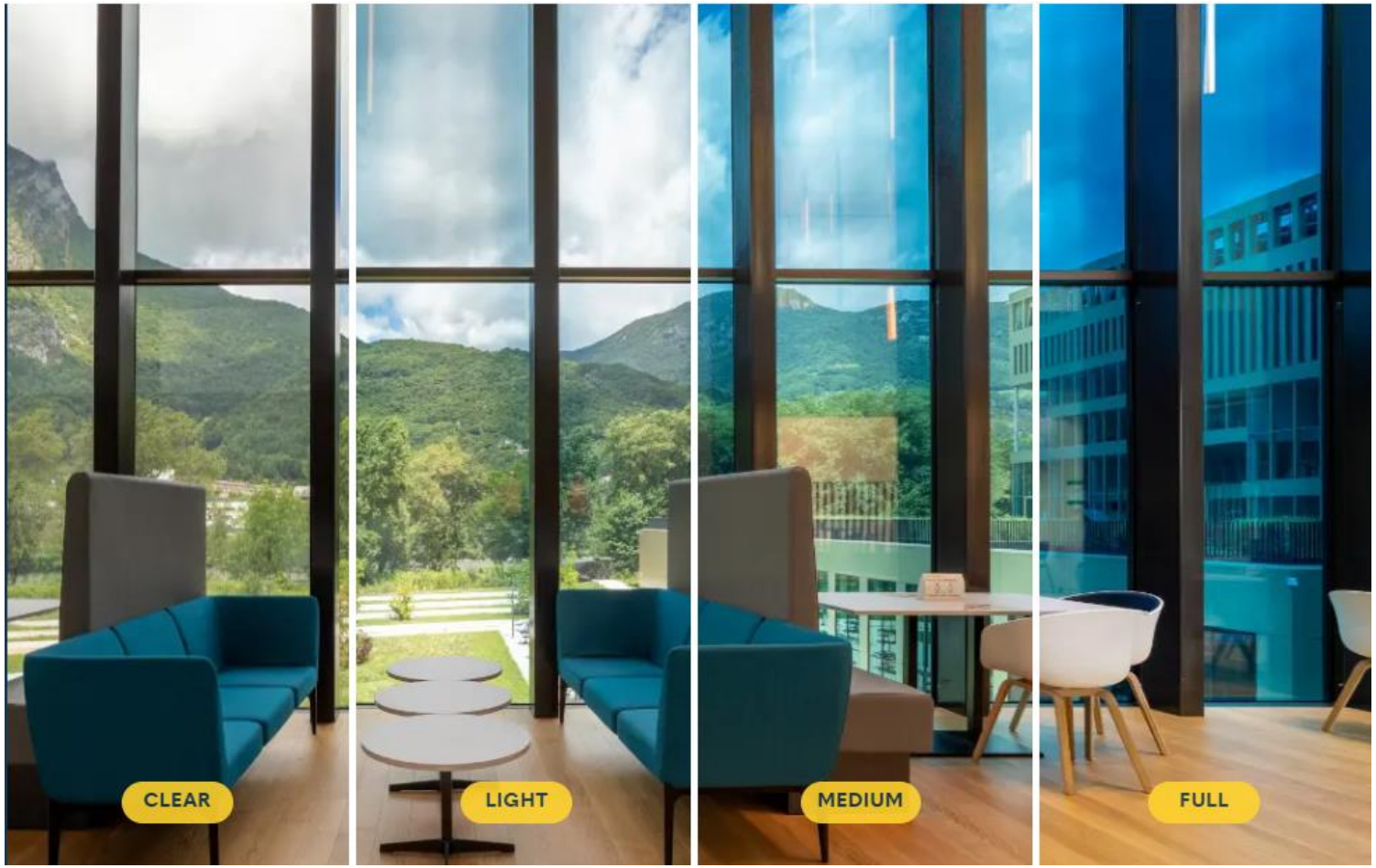
Attribute	Monolithic (Single-Pane) Glass 6mm Clear	Double-Glazed IGU *Solarban*® 70 (2) Clear + Clear	Triple-Glazed IGU *Solarban*® 70 (2) Clear + Clear	*VacuMax*™ VIG *Solarban*® 70
U-Value (Btu/hr•ft2•°F)	1.02	0.28	0.15	**0.05**
R-Value	1.00	3.60	6.66	**20.00**
Visible Light Transmittance (VLT)	89%	64%	47%	**62%**
Solar Heat Gain Coefficient (SHGC)	0.82	0.27	0.21	**0.25**
STC/OITC*	32/29	34/29	40/32	**27/30**
Seal Strength	N/A	150psi	150psi	**3000psi**
Thickness	6 mm	25 mm	44 mm	**8.3 mm**

Above data is for reference only. Calculation method not approved yet by National Fenestration Rating Council (NFRC) for VIG units. Specific product configurations, including substrates and low-e coatings, may affect the performance of constructed glazing systems.

**STC/OITC Tolerance +/-2*

https://www.vitroglazings.com/products/specialty-glass-applications/vacumax-vacuum-insulating-glass/

Electrochromic Glass



- Glass can leave interior with a blue tint
- Exterior can get quite dark and patchy
- Wiring through mullions is incredibly expensive

https://www.sageglass.com/smart-windows/product-overview

https://www.viracon.com/wp-content/uploads/2021/07/Brochure_Viracon-PLUS-Smart-Glass-powered-by-Halio.pdf

Fenestration U-factors & Max Area Table C402.4

U-0.34 for curtain wall, storefront, & Class AW windows

- U-0.36 for operable

U-0.26 for "all other"

- Mostly punched windows
- U-0.28 for operable

SHGC: 0.38 fixed

- 0.33 operable

C402.4.1 Maximum area. The total building vertical fenestration area (not including opaque doors and opaque spandrel panels) shall not exceed 30 percent of the total building gross above-grade wall area.

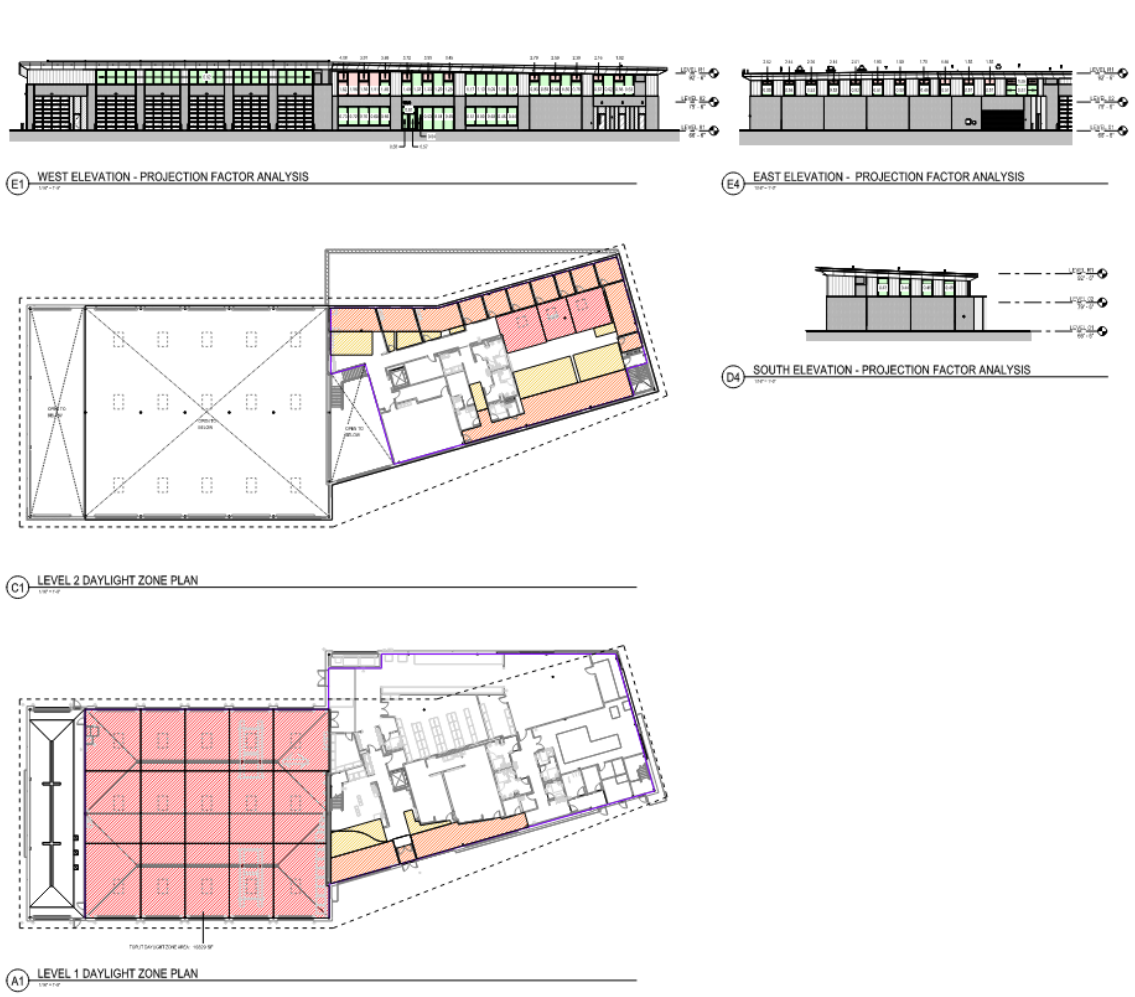
(Seattle same as WA code)

High-performance fenestration area & U-factor

C402.4.1.1 Vertical fenestration maximum area with high performance alternates. For buildings that comply with Section C402.4.1.1.1 or C402.4.1.1.2, the total building vertical fenestration area is permitted to exceed 30 percent but shall **not exceed 40 percent** of the gross above grade wall area for the purpose of prescriptive compliance with Section C402.1.4.

- **U-0.31** (operable 0.36)
  - Site-built (curtain wall, storefront, etc.)
  - Class AW windows
- **U-0.23** (operable 0.24)
  - *"A*ll other" vertical fenestration
  - Mostly punched windows

Daylight Credit



- This has gotten increasingly difficult to achieve
- My first project with this passed easily 10 years ago
- My next project was an office tower design for daylight 5 years ago, it barely passed
- My most recent project was a two-story electric bus shop and office with loads of skylights and a thin floor plate; it passed by a hair!

NFRC: Curtain Wall, Storefront...

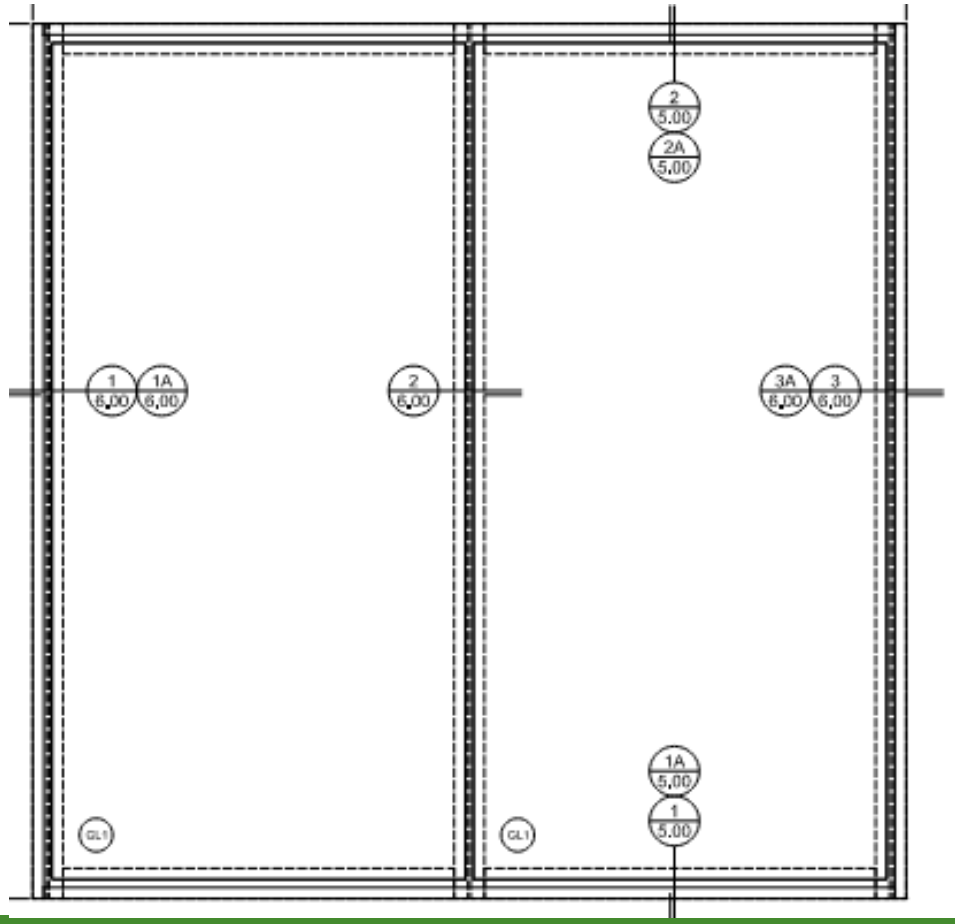
- NFRC "CMA Bid Report" OK, less $$ than "simulation report"
  - But not AAMA reports, mfr's simulation reports, or product literature
- NFRC Label Certificate *must* be available on site before the first stick of curtain wall goes up
  - … Certificate values must at least equal Bid Report values
  - See Tip 403 for more NFRC information

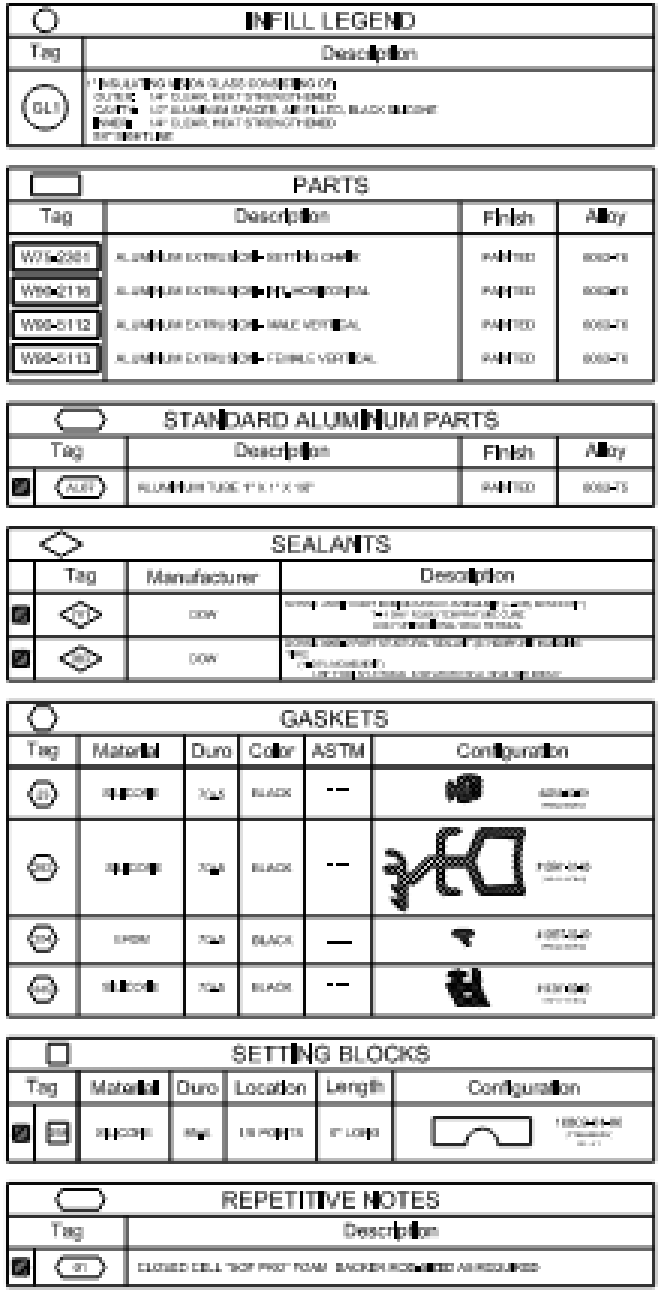
PRODUCT LISTING:

ID	Qty	Total Area	Name	EnergyPlus Report File	Fenestration Performance at Actual Size*				
					Width	Height	U-factor	SHGC	VT
		ft^2	ft^2		in.	in.	Btu/ $hr \cdot ft^2 \cdot {}^\circ F$	-	-
P-PL-010	2	48.00	PL-2200 / PL-2210	www.nfrc.org/CMAST/pl2200-2210.txt	48.00	72.00	0.48	0.59	0.66
P-PL-010	5	88.89	PL-2200 / PL-2210	www.nfrc.org/CMAST/pl2200-2210.txt	40.00	64.00	0.50	0.56	0.64
P-PL-005	6	192.67	PL-3400 / PL-3401	www.nfrc.org/CMAST/pl3400-3401.txt	68.00	68.00	0.49	0.58	0.65
P-PL-005	3	54.00	PL-3400 / PL-3401	www.nfrc.org/CMAST/pl3400-3401.txt	72.00	36.00	0.51	0.55	0.62

NFRC Test Size vs. Reality

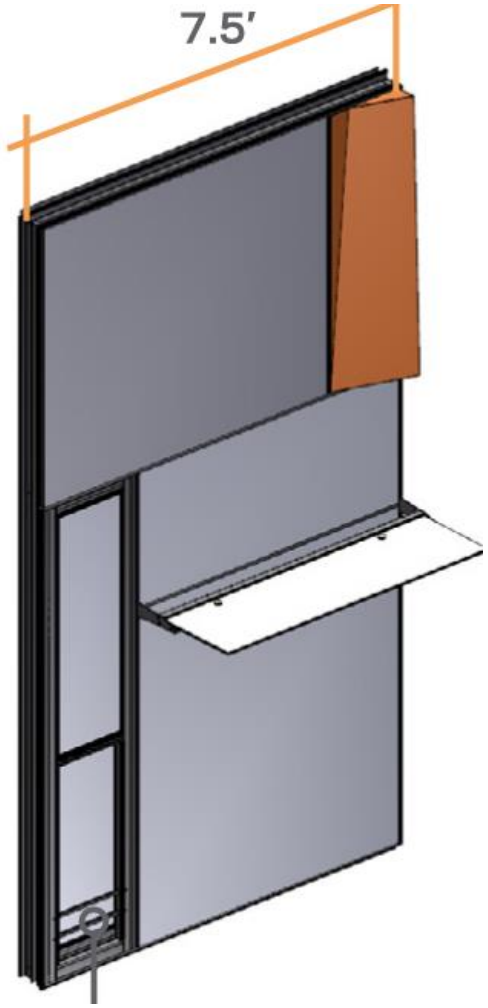
NFRC value will typically be worse than your actual U-factor due to size!





Look at larger units

- On a recent project we were wracking our brains to figure out how to get our U values down
- Aluminum is the enemy
- It turns out that 5’ units are standard, but that 7.5’ units fit in the elevator and work just fine
- We saved 15% on U value, 1100 tons of C02, and 5% of cost just with this one simple change!

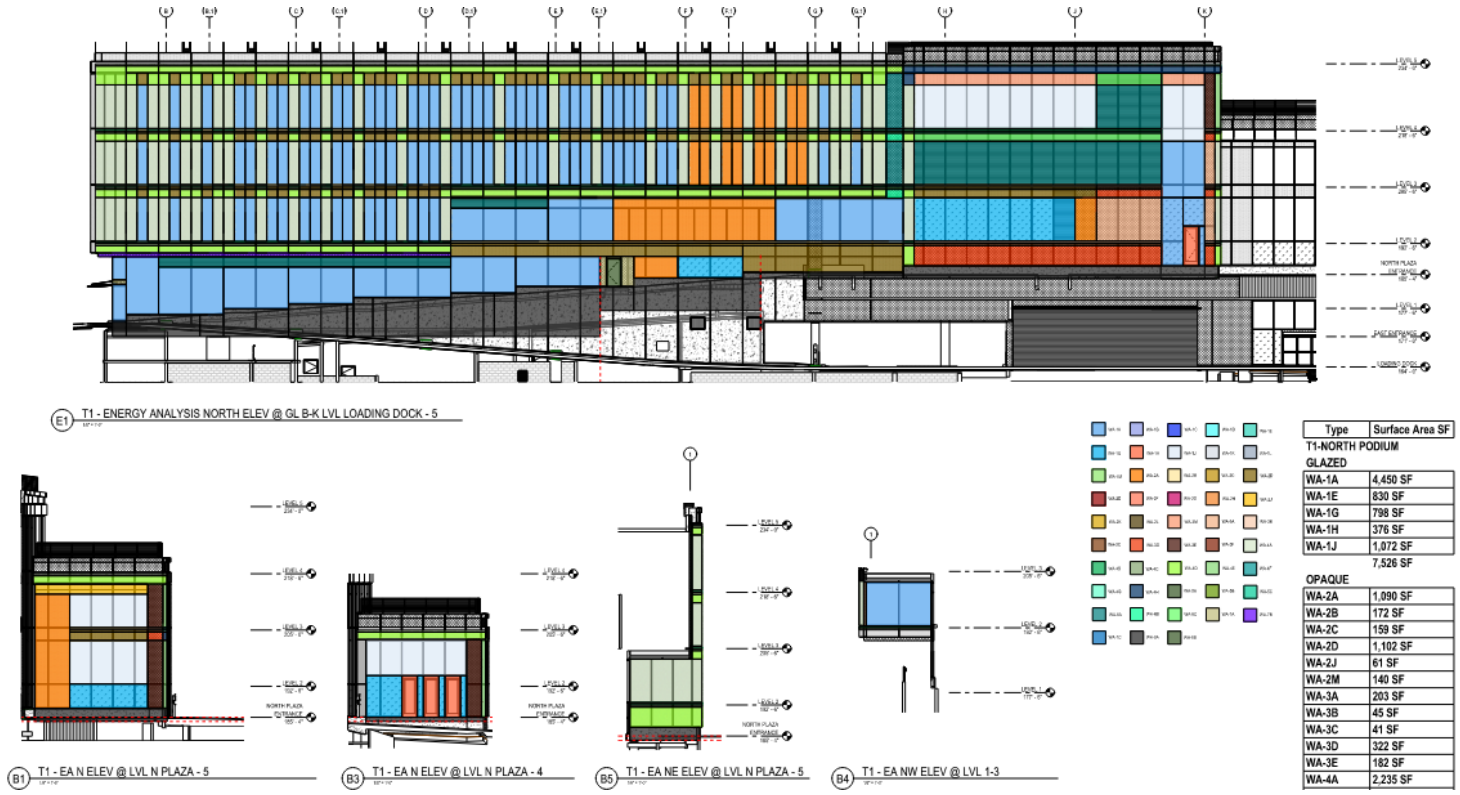


NFRC: Manufactured Windows

- Includes most “punched openings”
  - Except “Class A” (high wind load)
- Values shown on the window stickers must be at least as good as the values shown on plans
  - Don’t use the default table values in Chapter 3 unless there’s no NFRC value

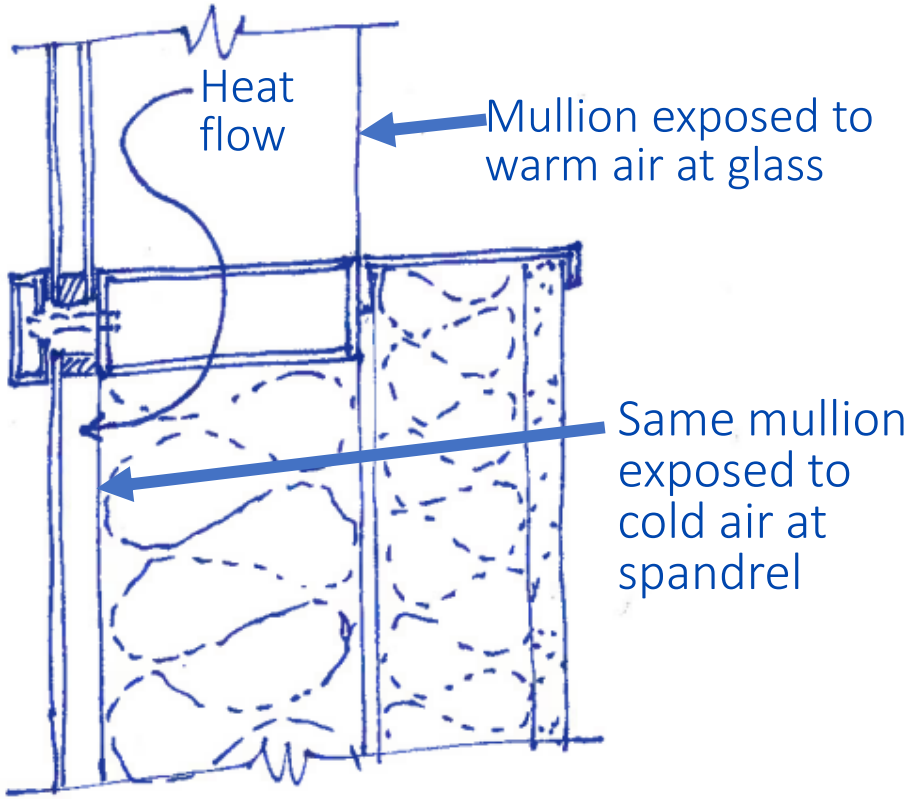
NFRC is always a problem

- Get your contractor to provide NFRC Label Certificates early
- They are always higher than expected
- Nothing is worse than redesigning a building in CDs, (or in CA) because the NFRCs didn't come in!
- They are always the last piece of the energy puzzle to come in and have the most impact!



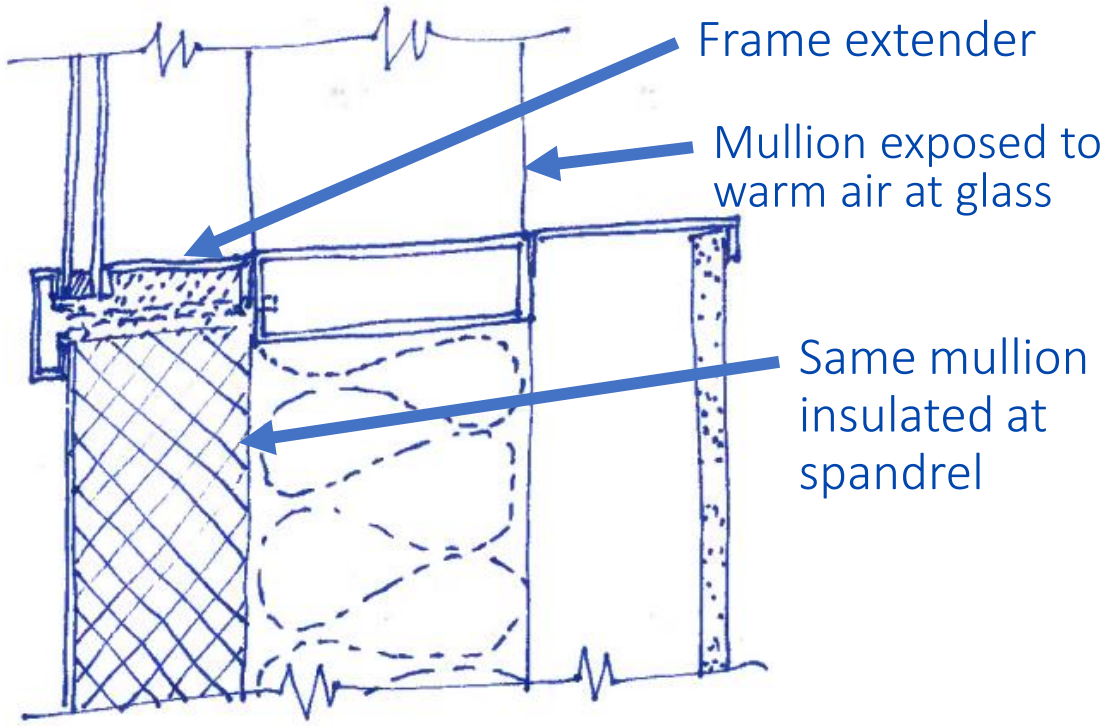
Type	Surface Area SF
T1-NORTH PODIUM	
GLAZED	
WA-1A	4,450 SF
WA-1E	830 SF
WA-1G	798 SF
WA-1H	376 SF
WA-1J	1,072 SF
	7,526 SF
OPAQUE	
WA-2A	1,090 SF
WA-2B	172 SF
WA-2C	159 SF
WA-2D	1,102 SF
WA-2J	61 SF
WA-2M	140 SF
WA-3A	203 SF
WA-3B	45 SF
WA-3C	41 SF
WA-3D	322 SF
WA-3E	182 SF
WA-4A	2,235 SF

Pet Peeve, with potential cure: Curtain wall to spandrel heat flow



Traditional Curtain Wall

The heat loss superhighway

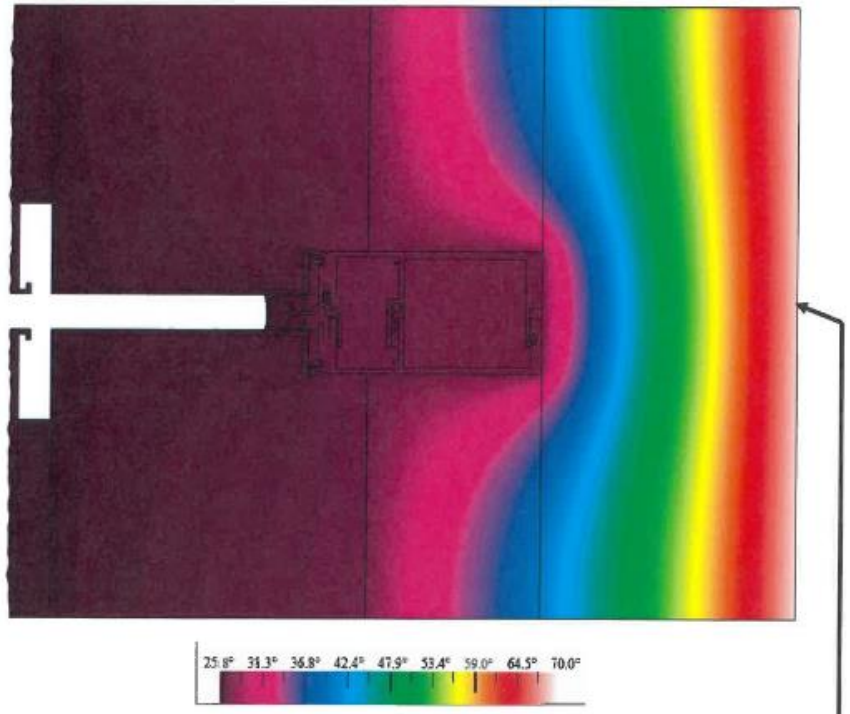


Improved Curtain Wall

Condensation Risk with more insulation is real!

DEWPOINT TEMPERATURE ANALYSIS: TEMPERATURE DISTRIBUTION PLOT

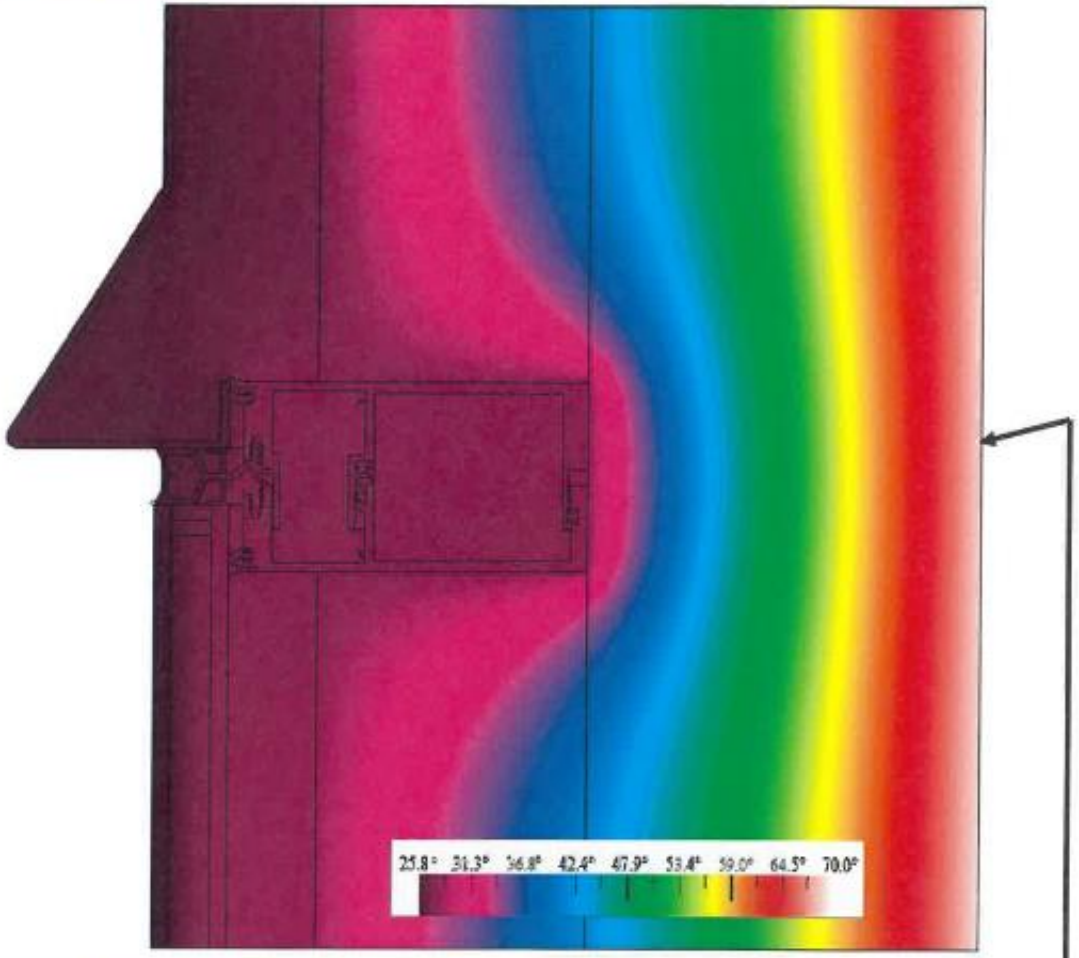
Cross Section	2/656
Exterior Air Temperature	25.8°F
Interior Air Temperature	70°F
Relative Humidity	36% RH
Exterior Wind Velocity	15 mph



Dewpoint Temperature	41.9°F
Coldest Interior Frame Temperature	68.7°F
Edge of Glass Temperature	-
Coldest Interior Temperature	68.7°F

DEWPOINT TEMPERATURE ANALYSIS: TEMPERATURE DISTRIBUTION PLOT

Cross Section	1/6103
Exterior Air Temperature	25.8°F
Interior Air Temperature	70°F
Relative Humidity	36% RH
Exterior Wind Velocity	15 mph



Dewpoint Temperature	41.9°F
Coldest Interior Frame Temperature	68.8°F
Edge of Glass Temperature	-
Coldest Interior Temperature	68.8°F

This risk is real

- Recently had to redesign all of the insulation on a large tower to move the vapor barrier back at vertical mullions
- Include condensation simulation in your shop drawing specifications!
- Get your engineers to simulate condensation before you get to shop drawings!
  - This is incredibly complex as it depends on outside temps, inside temps, and occupancy
  - IE do not try to wing this on your own

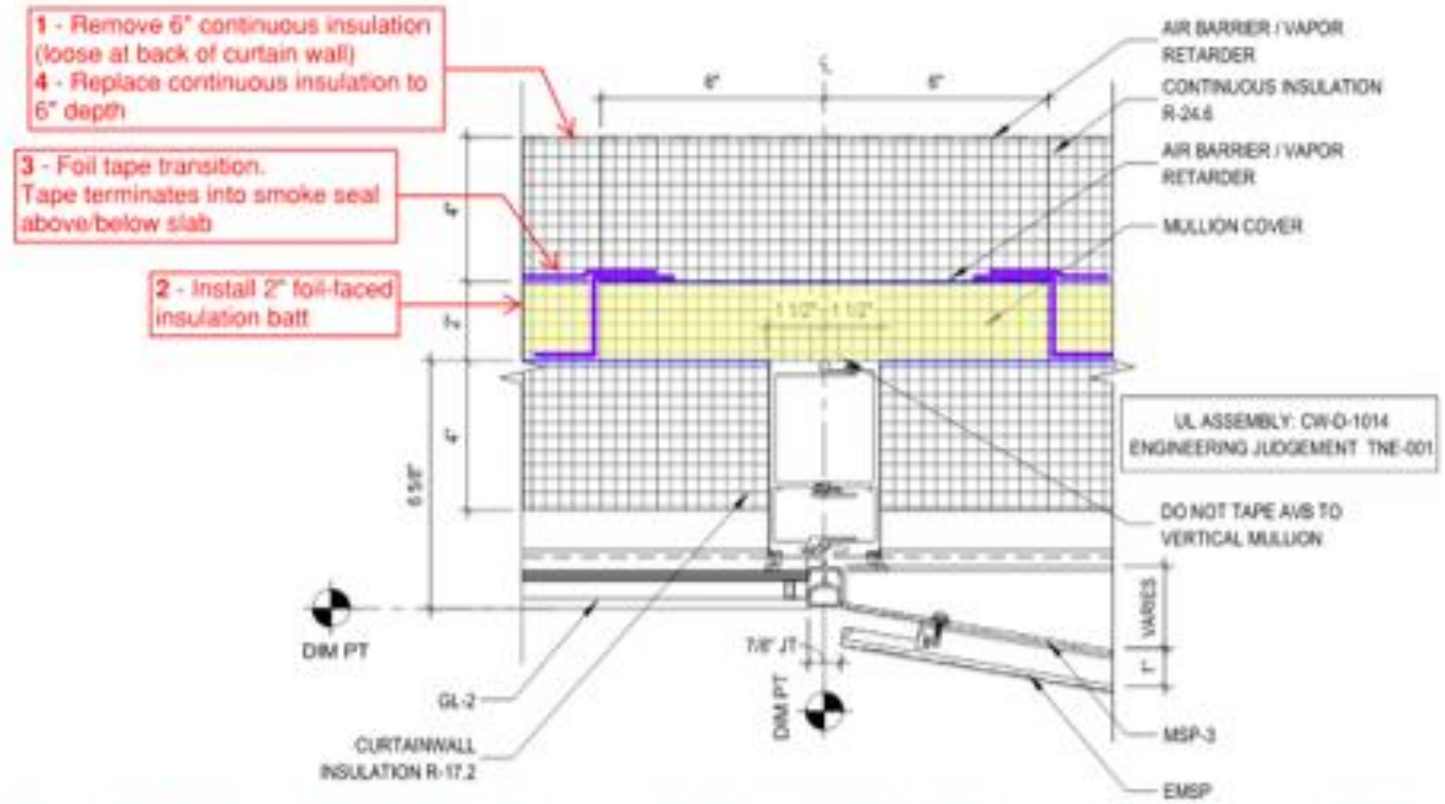


Figure 2: Outline plan detail and process for local shifting of the vapor barrier at spandrels

C407.3.1 Limits on substandard building envelopes

The Proposed Total UA of the proposed building shall be no more than ((~~20~~)) 10 percent higher than the Allowed Total UA as defined in Section C402.1.5.

WA code: UA max 20% worse than prescriptive.

Seattle: UA max 10% worse than prescriptive.

What could you do with the simulation money?

- It is important to ask yourself what you could do with the money for a simulation
- At 10 % UA savings, the juice is frequently not worth the squeeze
- You will need to do 90% of the work of Component Performance and then will have to do all of the simulation work!

U x A CALCULATION

Project Title	Microsoft Commute Electric Vehicle Facility - 2021 WSEC					Date	Jul 02, 2024
U x A Calculation	NEW BUILDING - FULLY CONDITIONED				COMPLIES		
Opaque Envelope Assemblies		PROPOSED			TARGET		
Roof/Ceiling	Assembly ID	Roof/Ceiling Assembly U-Factor	Net Area (SF)	U x A	Roof/Ceiling Assembly U-Factor	Net Area (SF)	U x A
Insulation entirely above deck	ECR-1	0.025	22,146.0	553.7	0.027	22,146.0 (1)	597.9
Insulation entirely above deck	ECR-2	0.019	2,176.0	41.3	0.027	2,176.0 (1)	58.8
Walls	Assembly ID	Wall Assembly U-factor	Net Area (SF)	U x A	Wall Assembly U-factor	Net Area (SF)	U x A
Steel-framed - Commercial	EC-1	0.044	7,488.0	329.5	0.055	7,488.0 (1)	411.8
Steel-framed - Commercial	EC-2	0.047	5,354.0	251.6	0.055	5,354.0 (1)	294.5
Mass (precast concrete) - Commercial	EC-3	0.073	150.0	11.0	0.104	150.0 (1)	15.6
Mass (precast concrete) - Commercial	EC-4	0.090	415.0	37.4	0.104	415.0 (1)	43.2
Mass (precast concrete) - Commercial	EC-5	0.089	837.0	74.5	0.104	837.0 (1)	87.0
Walls - Thru-Wall Mech Equipment	Assembly ID	U-Factor	Net Area (SF)	U x A	U-Factor	Net Area (SF)	U x A
Steel-framed wall	ECLV-1	0.5	55.0	27.5	0.055	55.0 (1)	3.0
Slab on Grade Floors		PROPOSED			TARGET		
Slab-on-grade Floors	Assembly ID	F-Factor	Perimeter Length (LF)	U x A	F-Factor	Perimeter Length (LF)	U x A
Unheated slab	ECS-2	0.54	675.0	364.5	0.54	675.0 (1)	364.5
Heated slab	ECS-1	0.55	456.0	250.8	0.55	456.0 (1)	250.8
Fenestration Assemblies		PROPOSED			TARGET		
Opaque Doors	Assembly ID	Door Assembly U-Factor	Assembly Rough Opening (SF)	U x A	Door Assembly U-Factor	Assembly Rough Opening (SF)	U x A
Swinging	ECDS-1	0.31	104.0	32.2	0.37	104.0 (1)	38.5
Swinging	ECDS-2	0.31	29.0	9.0	0.37	29.0 (1)	10.7
Swinging	ECDS-3	0.31	56.0	17.4	0.37	56.0 (1)	20.7
Garage - Glazed ≥14¼ & ≤50%	ECGR-3	0.27	502.0	135.5	0.34	502.0 (1)	170.7
Vertical Fenestration	Assembly ID	Fenestration U-Factor	Assembly Rough Opening (SF)	U x A	Fenestration U-Factor	Assembly Rough Opening (SF)	U x A
Fixed - Class AW or site built	ECGL-1	0.33	2,877.0	949.4	0.34	2,877.0 (1)	978.2
Operable - Class AW or site built	ECGL-2	0.38	300.0	114.0	0.36	300.0 (1)	108.0
Glazed Doors	Assembly ID	Glazed Door U-Factor	Assembly Rough Opening (SF)	U x A	Glazed Door U-Factor	Assembly Rough Opening (SF)	U x A
Swinging entrance door	ECDG-1	0.47	56.0	26.3	0.60	56.0 (1)	33.6
Garage door - > 50% glazed	ECGR-1	0.29	2,008.0	582.3	0.28	2,008.0 (1)	562.2
Garage door - > 50% glazed	ECGR-2	0.3	564.0	169.2	0.28	564.0 (1)	157.9
Skylights	Assembly ID	Skylight U-Factor	Assembly Rough Opening (SF)	U x A	Skylight U-Factor	Assembly Rough Opening (SF)	U x A
All types	ECSK-1	0.48	405.0	194.4	0.50	405.0 (1)	202.5
All types	ECSK-2	0.48	54.0	25.9	0.50	54.0 (1)	27.0

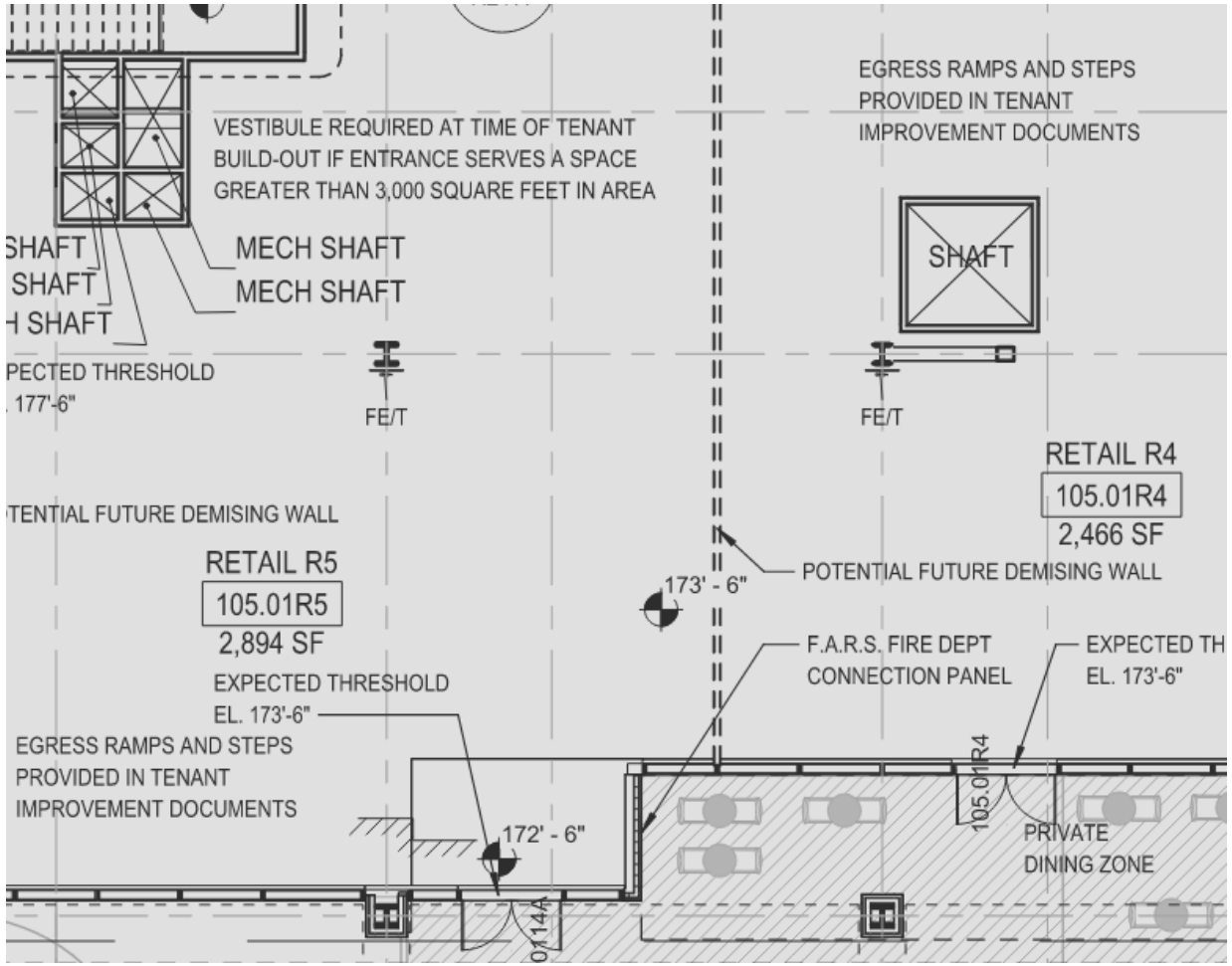
	Proposed Area	Proposed UxA	Target Area	Target UxA
Project Totals	46,707	4,197	46,707	4,437

Vestibules: They don’t have to be boring

- Vestibules required at all building entrances for public or occupants
  - Unless smaller than 3000 SF
- *Not* required at service doors, exit doors, small storefronts, outdoor dining
- Required for swing doors next to revolving doors
- Exception for air curtains!

Vestibules can be a real Killer for Retail Clients

- Add text to all of your drawings that retail spaces larger than 3,000 sf must have a vestibule or you will have a very surprised owner!
- This note cannot be too large!
  - Retailers are frequently another group or even a separate company than the owners
  - Retail design frequently occurs long after core and shell and is often a different design team
  - Owners really want retailers
  - If your owner leases a space to a retailer without realizing a vestibule is required there will be hell to pay

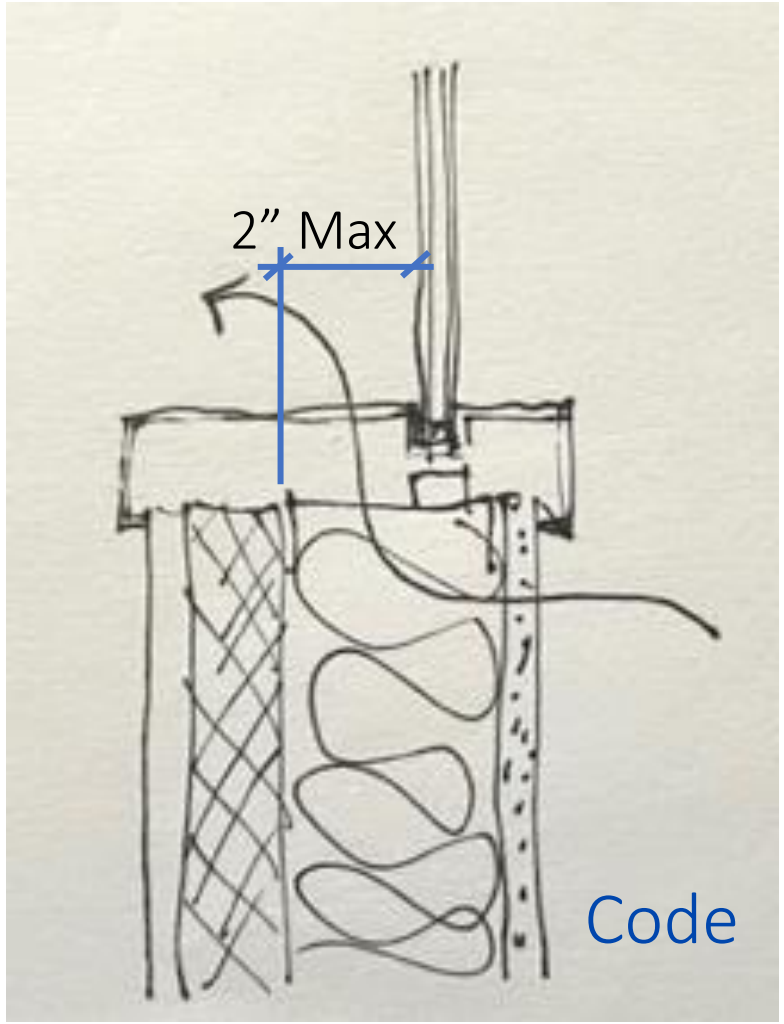


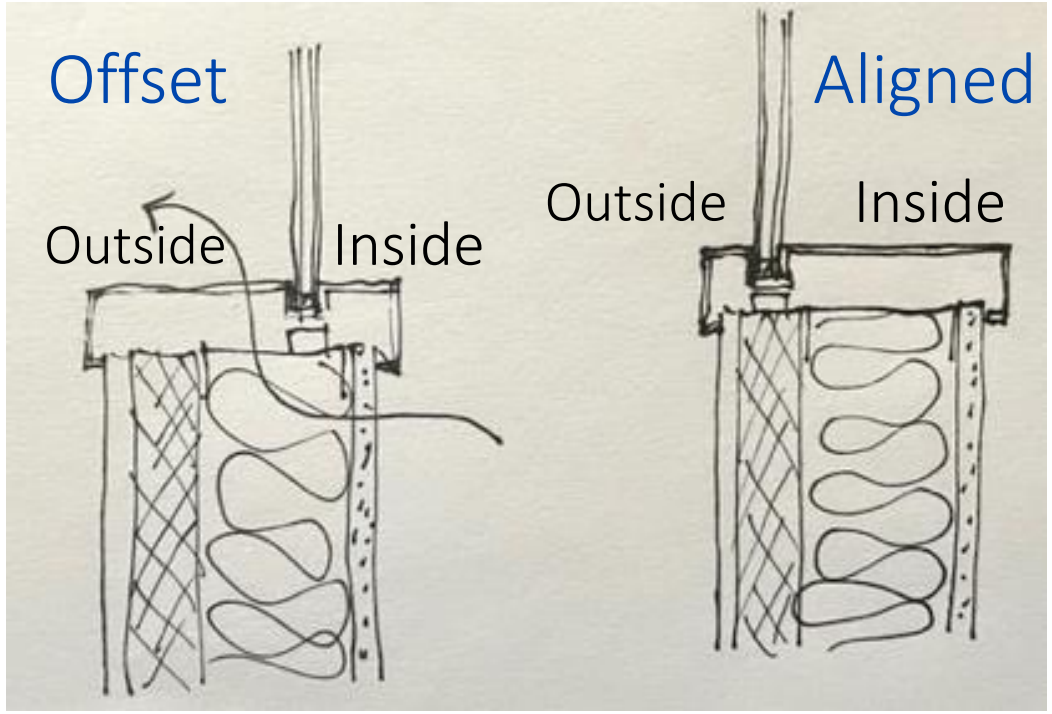
Thermal bridging

- Concrete balcony C402.2.8
  - Provide R-10 thermal break
    - Stainless steel re-bar penetrations OK
  - Or component performance (target UA)
    - If concrete slab is continuous through wall, use “exposed concrete” in table (U-0.741 for 8” slab)

Efficient Heat Dissipation!

Architects just love that “shadow line”



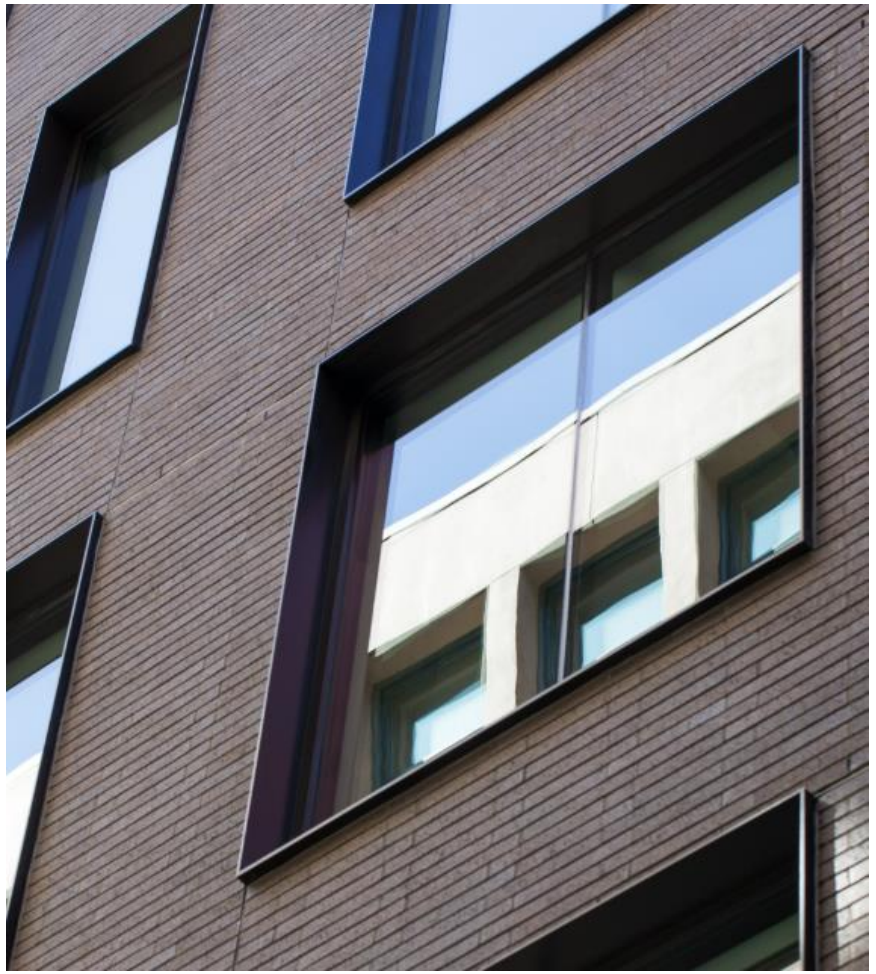


Fenestration frame C402.2.9

- Align continuous insulation & thermal break within 2” of glass plane
- Insulate “exposed” rough opening to R-3

Could you achieve that same look with a fin?

- Beyond energy issues, air barrier jogs are very expensive and difficult to waterproof
- A jogged detail like this will require three-dimensional flashing at every corner to keep the air barrier tight.
- If you have 1,000 windows that's 4,000 corners, a lot of dough, and a very unhappy client!

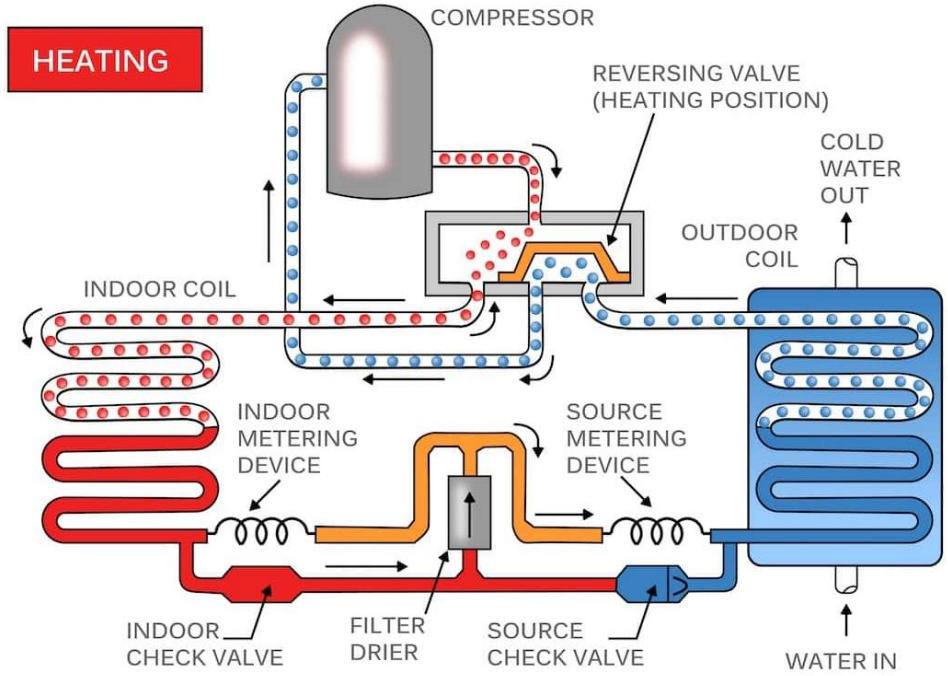


Heat pump space heating: Now in WA code

Primary space heating must be heat pump.

Exceptions allow electric resistance heat for:

1. Other space types: Max 2.5 W/sf total installed heating (The "Passive House" rule)
2. Dwelling units: Max **750 W** per habitable room (**1000 W** for corner room)
3. Heat pump auxiliary heat in cold weather
4. Buildings smaller than 2,500 sf



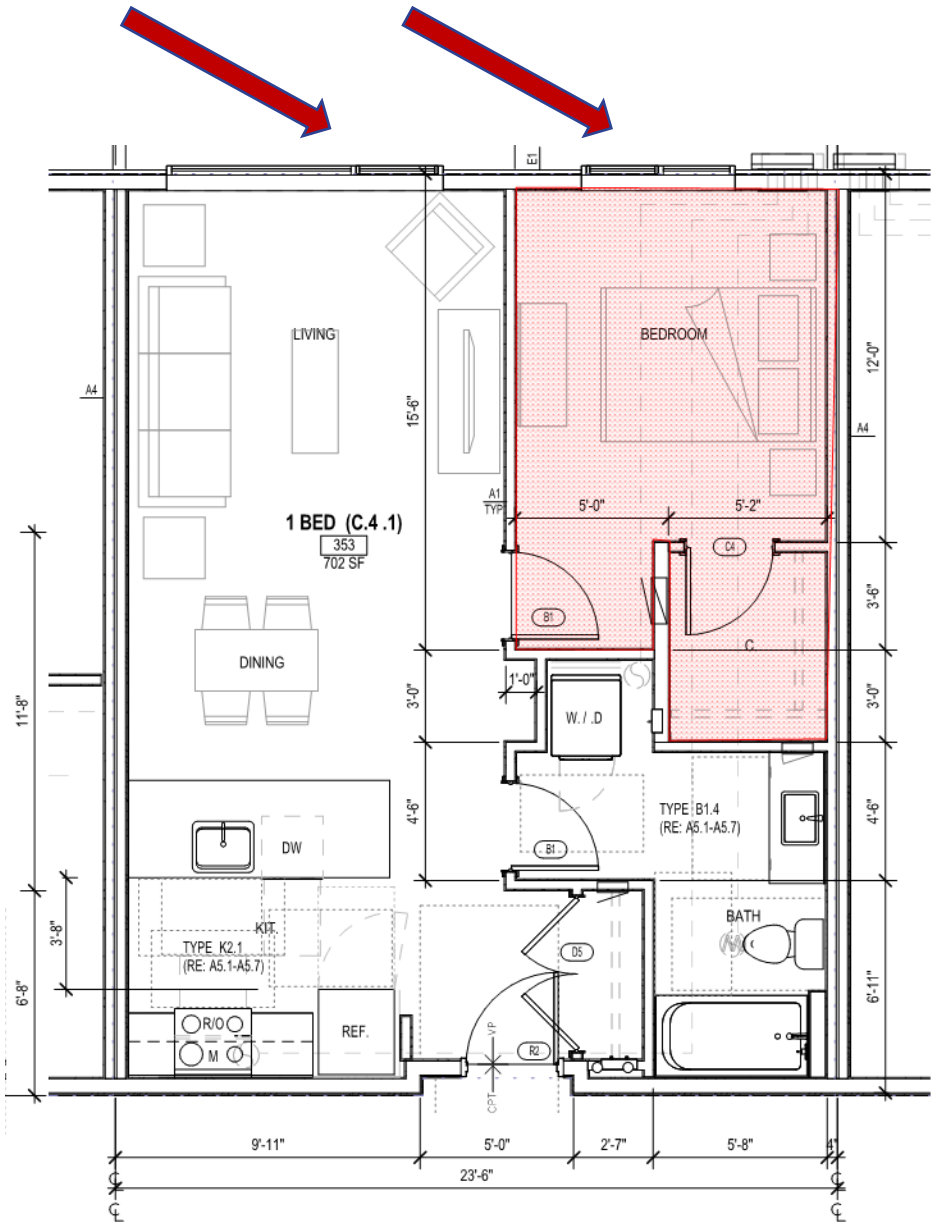
Heat pumps squeeze warmth out of cold air

Does your envelope design work for 750W?

Electric Resistance Case Studies

(Courtesy of RDH Building Science, based on 2018 code values)

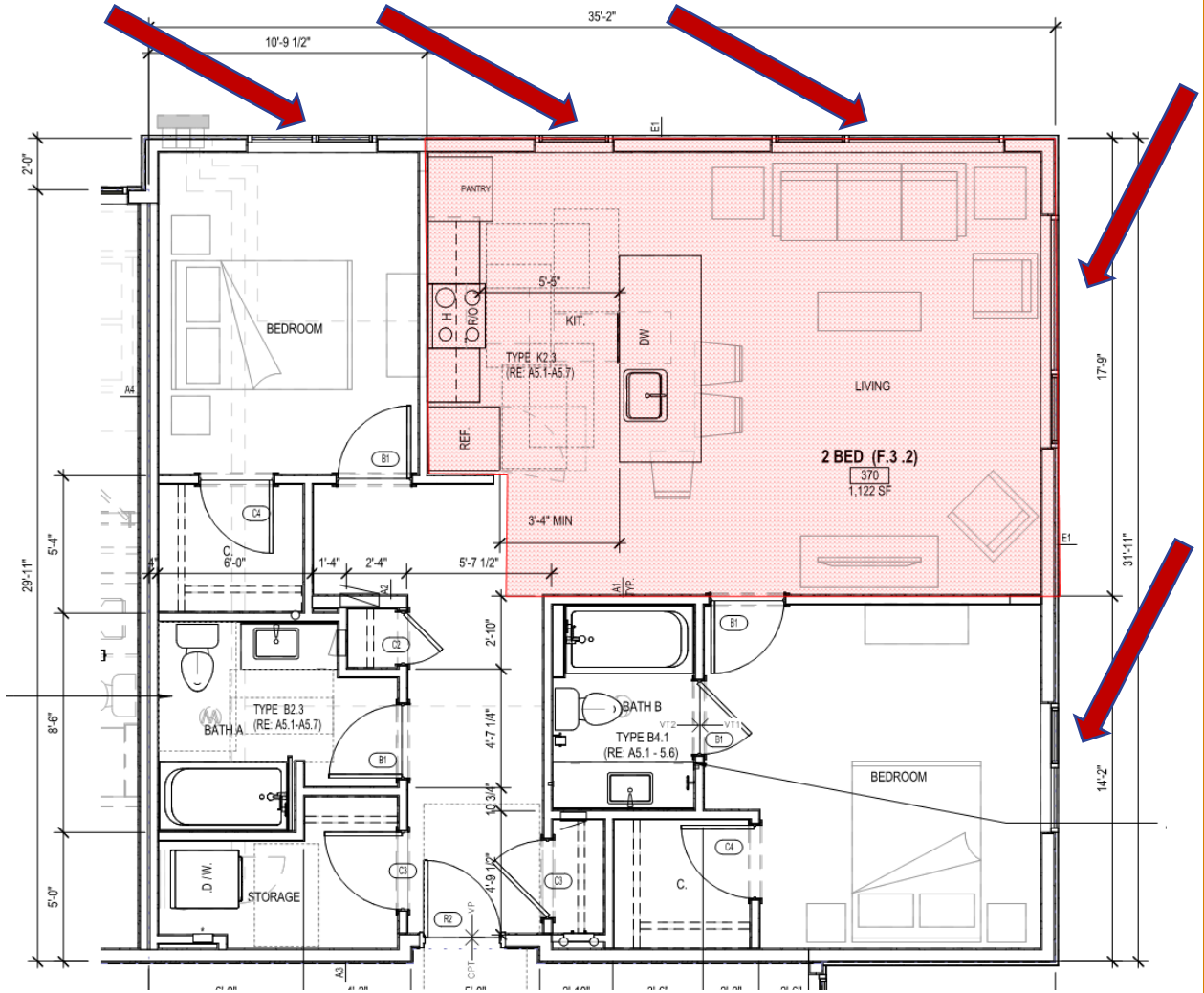
- Typical Bedroom <750W.
- One large (6'x7') sliding glass door (40% glazing).
  - Wood-Framed Construction with punched windows
    - Heat Capacity ≈ 400W
  - Steel-Framed Construction with unitized glazing
    - Heat Capacity ≈ 475W
- Takeaway: Large glazing % still possible for small rooms with 10-12 feet of exterior wall



Electric Resistance Case Studies

(Courtesy of RDH Building Science, based on 2018 code values)

- Corner Living Room
- 24’x18’ living room
- 35% glazing
  - Wood-Framed Construction with punched windows
    - Heat Capacity ≈ 1000W
  - Steel-Framed Construction with unitized glazing
    - Heat Capacity ≈ 1200W
    - Decrease glazing u-value to **U-0.30** to reduce heating capacity to 1kW
- Takeaway: It may be challenging to meet loads in corner units due primarily to higher enclosure areas. Close review required
- These are small capacities!



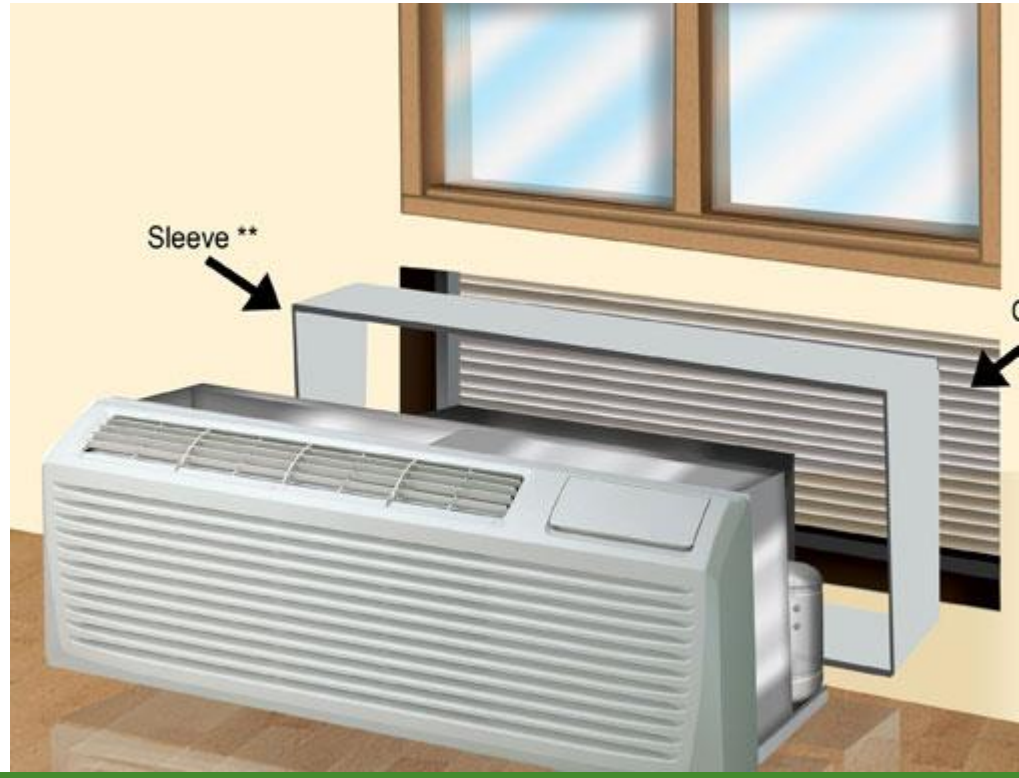
PTAC/PTHP: recognize thru-wall heat loss

C402.1.4.3 Thermal resistance of mechanical equipment penetrations. When the total area of penetrations from through-wall mechanical equipment or equipment listed in Table C403.3.2(3) **exceeds 1 percent** of the opaque *above-grade wall* area, the mechanical equipment penetration area shall be calculated as a separate wall assembly with a **default U-factor of 0.5**…

Exception: Where mechanical equipment has been tested in accordance with *approved* testing standards…

135 ft^2 = 15’ x 9’ wall area

7 ft^2 = PTHP = 5% of area



Through-wall mechanical equip (PTAC/PTHP)

Table C402.1.4: footnote k for above-grade wall types:

Walls, Above Grade[k]		
Mass[g]	((~~U-0.104[d]~~)) U-0.057	((~~U-0.078~~)) U-0.057
Mass transfer deck slab edge[i]	U-0.20	U-0.20
Slab penetrating thermal envelope wall[h]	U-0.10	U-0.10
Metal building	U-0.050	U-0.050
Steel framed	U-0.055	U-0.055
Wood framed and other	U-0.051	U-0.051

k. Through-wall mechanical equipment subject to Section C402.1.4.2 shall be calculated at the U-factor defined in Section C402.1.4.2. The area-weighted U-Factor of the wall, including through-wall mechanical equipment, shall not exceed the value in the table.
(U-0.500 vs U-0.056)

Seattle (Table C402.1.4) Special case U-factors

g. Peripheral edges of intermediate concrete floors are included in the above-grade mass wall category and therefore must be insulated as above-grade mass walls unless they meet the definition of *Mass Transfer Deck Slab*. The area of the peripheral edges of concrete floors shall be defined as the thickness of the slab multiplied by the perimeter length of the edge condition.

l. Value applies to concrete columns and concrete walls that interrupt mass floor insulation, but not to perimeter walls or columns separating interior *conditioned space* from exterior space.

Walls, Above Grade[k]		
Mass[g]	((~~U-0.104~~[d])) U-0.057	((~~U-0.078~~)) U-0.057
Mass transfer deck slab[i]	U-0.20	U-0.20
Slab penetrating thermal envelope wall[g]	U-0.10	U-0.10
Metal building	U-0.052	U-0.052
Steel framed	U-0.055	U-0.055
Wood framed and other	U-0.051	U-0.051
Floors		
Mass[e]	U-0.031	U-0.031
Joist/framing	((~~U-0.029~~)) U-0.029 steel joist U-0.025 wood joist	((~~U-0.029~~)) U-0.029 steel joist U-0.025 wood joist
Concrete column or concrete wall penetrating thermal envelope floor[l]	U-0.55	U-0.55
Concrete slab floor directly above electrical utility vault	N.R.	N.R.

Air Barrier Testing C402.5.2

- Test standard is **0.25** cfm/sf of envelope area
- Passing test at 0.25 is **mandatory**
  - (keep testing till you pass)

- Either test the whole building,
  - Or all stories directly under a roof, stories with entrance, loading dock, exposed floor, or below grade
  - …plus 25% of above-grade walls

Potential mechanical system impacts

- Smoke control system? Make sure engineer understands envelope air tightness
- Tight envelope will significantly reduce stack effect
- Question need for building pressurization in a building with 0.25 cfm air leakage
  - “Normal” leakage will be only about 0.01 cfm
  - Could save major fan energy

FSAE Primary Recall Only - Closed Windows

Scenario: Winter
Wind Speed: 0.0 mph at 320°
Ambient Temperature: 12.4 °F
Shaft Temperature: 21.0 °F
Building Temperature: 70.0 °F
Open to exterior
Recall Floor
Powered Opener
Note: All door forces are based on a 3' x 7' door unless otherwise indicated.

Level	Stair Number 1		Stair Number 2 - FSAE Lobby		Stair Number 2 - Tenant		Stair Number 3		Elevator Hoistway Number A/B/C/D	Elevator Hoistway Number E/F/G/H	Elevator Hoistway Number I/J/K/L	Elevator Hoistway Number M/N/O/P	Elevator Hoistway Number Q/R/S	Elevator Hoistway Number T/U/V	Elevator Hoistway Number W	Elevator Hoistway Number S1/S2	Level
	Pressure Difference (in. of H2O)	Door Force (lbf)	Pressure Difference (in. of H2O)	Door Force (lbf)	Pressure Difference (in. of H2O)	Door Force (lbf)	Pressure Difference (in. of H2O)	Door Force (lbf)	Pressure Difference (in. of H2O)	Pressure Difference (in. of H2O)	Pressure Difference (in. of H2O)	Pressure Difference (in. of H2O)	Pressure Difference (in. of H2O)	Pressure Difference (in. of H2O)	Pressure Difference (in. of H2O)	Pressure Difference (in. of H2O)	
P6	N/A	N/A	0.24	23.3	0.32	28.1	0.19	20.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.17	P6
P5	N/A	N/A	0.23	22.7	0.31	27.5	0.18	19.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.16	P5
P4	N/A	N/A	0.22	22.1	0.30	26.9	0.16	18.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.15	P4
P3	N/A	N/A	0.22	22.1	0.28	25.7	0.15	17.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.15	P3
P2	N/A	N/A	0.21	21.5	0.27	25.1	0.13	16.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.14	P2
P1	N/A	N/A	0.09	14.4	0.20	20.9	0.11	15.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	OPEN DOOR	P1
1	0.22	22.1	0.18	19.7	0.18 0.15 0.15	19.7 17.9 17.9	0.18	19.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.10	1
2	0.17	19.1	0.18	19.7	0.22	22.1	0.16 0.17	18.5 19.1	0.14	0.14	0.12	0.12	0.12	0.11	0.11	0.11	2
3	0.15	17.9	0.17	19.1	0.19	20.3	0.16	18.5	0.12	0.12	0.11	0.10	0.10	0.10	0.10	0.10	3
4	0.16	18.5	0.17	19.1	0.19	20.3	0.16	18.5	0.12	0.12	0.11	0.10	0.10	0.10	0.10	0.10	4
5	0.16	18.5	0.17	19.1	0.20	20.9	0.16	18.5	0.12	0.13	0.11	0.10	0.11	0.10	0.10	0.10	5
6	0.19	20.3	0.18	19.7	0.23	22.7	0.19	20.3	0.10	0.10	N/A	N/A	N/A	N/A	N/A	0.10	6
7	0.19	20.3	0.18	19.7	0.23	22.7	0.20	20.9	0.10	0.10	N/A	N/A	N/A	N/A	N/A	0.11	7
8	0.20	20.9	0.18	19.7	0.23	22.7	0.20	20.9	0.10	0.11	N/A	N/A	N/A	N/A	N/A	0.11	8
9	0.20	20.9	0.19	20.3	0.24	23.3	0.21	21.5	0.11	0.11	N/A	N/A	N/A	N/A	N/A	0.11	9
10	0.21	21.5	0.19	20.3	0.24	23.3	0.21	21.5	0.11	0.11	N/A	N/A	N/A	N/A	N/A	0.12	10
11	0.21	21.5	0.19	20.3	0.25	23.9	0.21	21.5	0.11	0.12	N/A	N/A	N/A	N/A	N/A	0.12	11
12	0.21	21.5	0.20	20.9	0.25	23.9	0.22	22.1	0.11	0.12	N/A	N/A	N/A	N/A	N/A	0.12	12
13	0.22	22.1	0.20	20.9	0.26	24.5	0.22	22.1	0.12	0.12	N/A	N/A	N/A	N/A	N/A	0.12	13
14	0.22	22.1	0.20	20.9	0.26	24.5	0.23	22.7	0.12	0.12	N/A	N/A	N/A	N/A	N/A	0.13	14
15	0.23	22.7	0.20	20.9	0.26	24.5	0.23	22.7	0.12	0.13	N/A	N/A	N/A	N/A	N/A	0.13	15
16	0.23	22.7	0.21	21.5	0.27	25.1	0.24	23.3	0.13	0.13	N/A	N/A	N/A	N/A	N/A	0.13	16
17	0.24	23.3	0.21	21.5	0.27	25.1	0.24	23.3	0.13	0.13	N/A	N/A	N/A	N/A	N/A	0.14	17
18	0.24	23.3	0.22	22.1	0.28	25.7	0.25	23.9	0.13	0.14	N/A	N/A	N/A	N/A	N/A	0.14	18
19	0.18	19.7	0.18	19.7	0.21	21.5	0.18	19.7	0.14	0.14	0.13	0.12	0.12	0.12	0.12	0.10	19
20	0.20	20.9	0.18	19.7	0.23	22.7	0.20	20.9	N/A	N/A	0.10	0.10	N/A	N/A	N/A	0.11	20
21	0.19	20.3	0.18	19.7	0.23	22.7	0.20	20.9	N/A	N/A	0.10	0.10	N/A	N/A	N/A	0.11	21
22	0.20	20.9	0.19	20.3	0.24	23.3	0.21	21.5	N/A	N/A	0.11	0.10	N/A	N/A	N/A	0.12	22
23	0.20	20.9	0.19	20.3	0.23	22.7	0.20	20.9	N/A	N/A	0.10	0.10	N/A	N/A	N/A	0.11	23
24	0.20	20.9	0.19	20.3	0.24	23.3	0.21	21.5	N/A	N/A	0.11	0.10	N/A	N/A	N/A	0.12	24
25	0.20	20.9	0.19	20.3	0.24	23.3	0.21	21.5	N/A	N/A	0.10	0.10	N/A	N/A	N/A	0.12	25
26	0.21	21.5	0.20	20.9	0.25	23.9	0.22	22.1	N/A	N/A	0.11	0.10	N/A	N/A	N/A	0.12	26
27	0.21	21.5	0.20	20.9	0.24	23.3	0.21	21.5	N/A	N/A	0.11	0.10	N/A	N/A	N/A	0.12	27
28	0.22	22.1	0.20	20.9	0.26	24.5	0.23	22.7	N/A	N/A	0.12	0.11	N/A	N/A	N/A	0.13	28
29	0.21	21.5	0.20	20.9	0.25	23.9	0.22	22.1	N/A	N/A	0.11	0.11	N/A	N/A	N/A	0.13	29
30	0.23	22.7	0.21	21.5	0.26	24.5	0.23	22.7	N/A	N/A	0.12	0.11	N/A	N/A	N/A	0.14	30
31	0.22	22.1	0.21	21.5	0.26	24.5	0.23	22.7	N/A	N/A	0.12	0.11	N/A	N/A	0.17	0.13	31
32	0.22	22.1	0.20	20.9	0.25	23.9	0.22	22.1	N/A	N/A	0.17	0.16	0.17	0.17	0.16	0.13	32
33	0.26	24.5	0.23	22.7	0.30	26.9	0.27	25.1	N/A	N/A	N/A	N/A	0.12	0.12	0.12	0.16	33
34	0.27	25.1	0.24	23.3	0.31	27.5	0.27	25.1	N/A	N/A	N/A	N/A	0.13	0.12	0.12	0.17	34
35	0.26	24.5	0.21	21.5	0.29	26.3	0.26	24.5	N/A	N/A	N/A	N/A	0.12	0.11	0.12	0.14	35
36	0.26	24.5	0.22	22.1	0.30	26.9	0.27	25.1	N/A	N/A	N/A	N/A	0.12	0.12	0.12	0.14	36
37	0.27	25.1	0.22	22.1	0.30	26.9	0.27	25.1	N/A	N/A	N/A	N/A	0.13	0.12	0.12	0.15	37
38	0.27	25.1	0.22	22.1	0.31	27.5	0.28	25.7	N/A	N/A	N/A	N/A	0.13	0.12	0.13	0.15	38
39	0.28	25.7	0.23	22.7	0.31	27.5	0.28	25.7	N/A	N/A	N/A	N/A	0.13	0.13	0.13	0.16	39
40	0.28	25.7	0.23	22.7	0.32	28.1	0.29	26.3	N/A	N/A	N/A	N/A	0.14	0.13	0.13	0.16	40
41	0.29	26.3	0.23	22.7	0.32	28.1	0.29	26.3	N/A	N/A	N/A	N/A	0.14	0.13	0.13	0.16	41
42	0.29	26.3	0.24	23.3	0.33	28.7	0.30	26.9	N/A	N/A	N/A	N/A	0.14	0.13	0.14	0.17	42
43	0.30	26.9	0.24	23.3	0.33	28.7	0.30	26.9	N/A	N/A	N/A	N/A	0.14	0.14	0.14	0.17	43
44	0.16	18.5	0.17	19.1	0.20	20.9	0.21	21.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	44
Roof	N/A	N/A	N/A	N/A	0.59	44.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Roof

You can't test an air barrier by "inspecting" it

Pressure testing makes air movement "visible"

Leakage happens through the material transitions & penetrations
Not through the "materials" & "assemblies" themselves

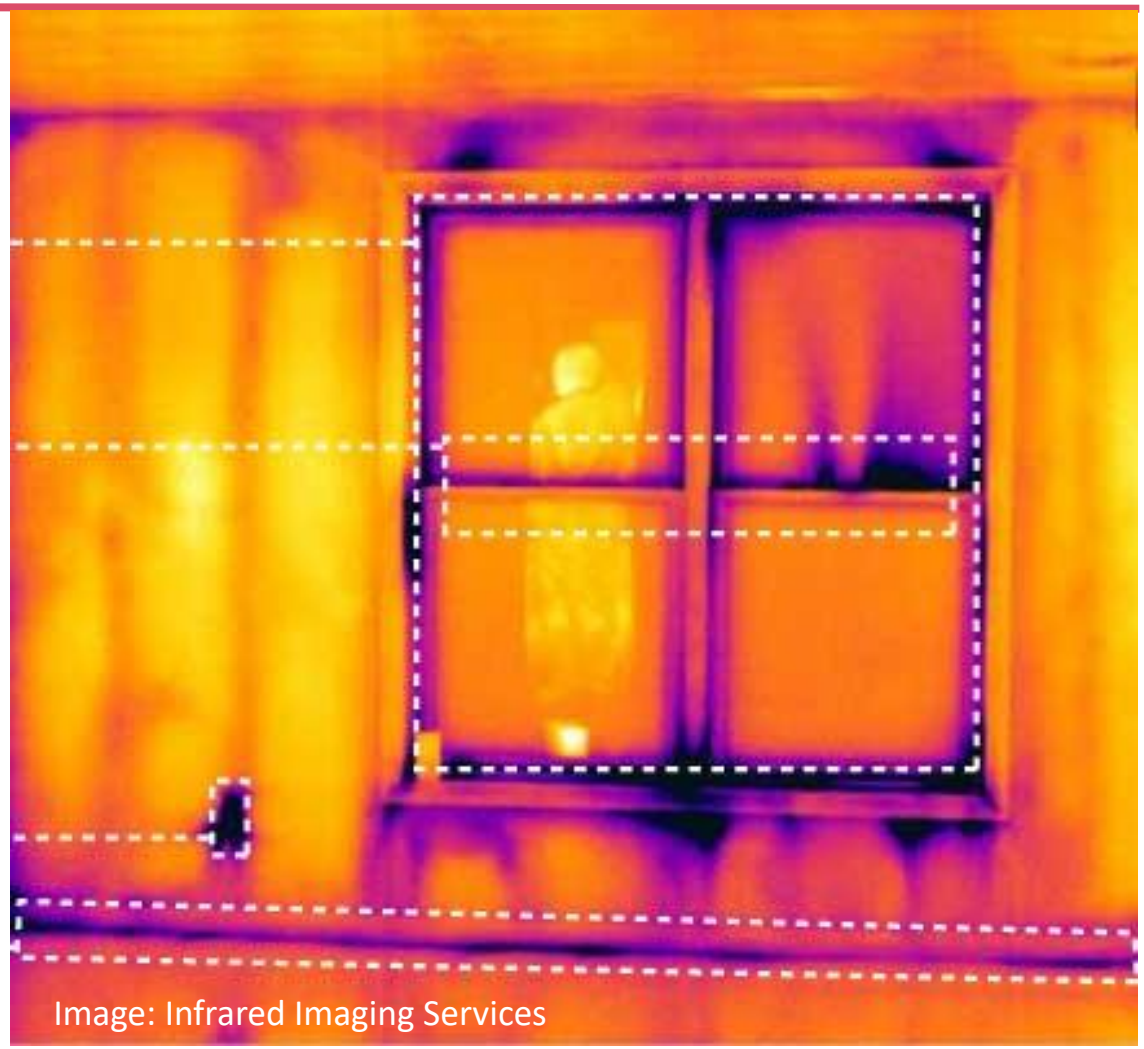
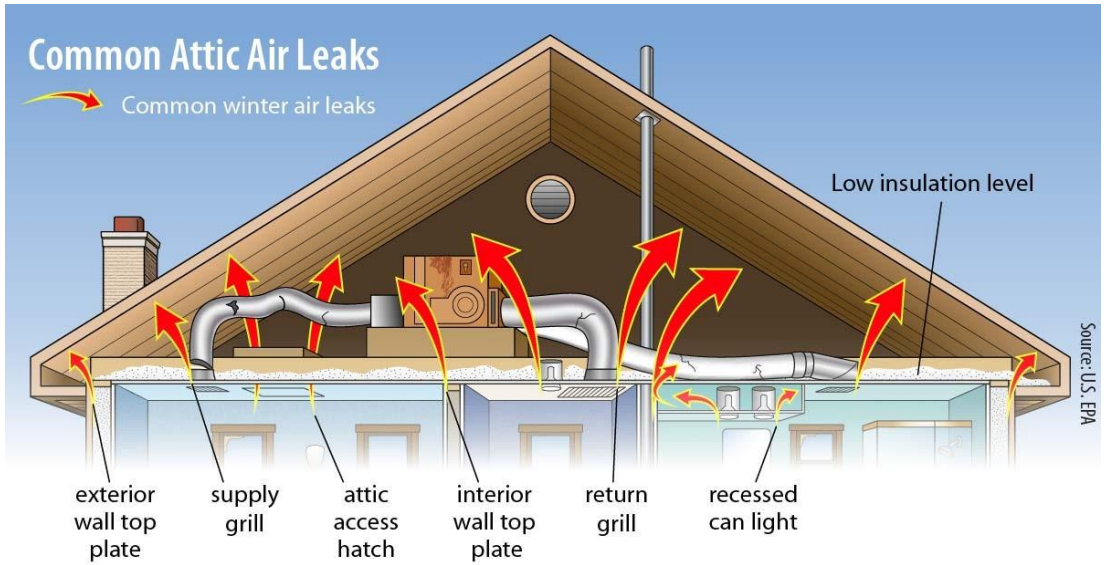


Image: Infrared Imaging Services

Air leakage Locations: The Top Ten



1. All “vented roof” assemblies!
2. Doors & frames – swinging, rolling, folding, everything
3. Range hoods & ducts
4. Mech penetrations – A/C line sets ganged together
5. Roof/parapet intersection
6. Fans - ventilation, elevator, etc. even w/ louvers closed
7. Window & curtain wall framing deformed at lift point
8. Elevator shaft to rooftop deck & parking level
9. Everything electrical
10. Trash chutes, laundry chutes, roof hatches

Semi-heated spaces
Only difference: Opaque wall insulation not required

C402.1.1.2, Semi-heated buildings and spaces.

- Definition: Between 3.4 and 8 BTUH installed heating capacity, but no cooling.
- Envelope requirements: Exactly the same, **except you don't have to install the opaque wall insulation**
  - Same windows, doors, slab insulation, roof insulation…

Exception: Provided the total installed heating output capacity of mechanical space conditioning does not exceed the criteria for semi-heated space as defined in Section C202, a semi-heated building or space is permitted to comply with this section **when served by heat pumps** without electric resistance back up and connected to a heating only thermostat.

Semi-heated: Ask yourself is this worth it!

- Documenting semi-heated spaces is incredibly difficult especially as you move through the garage.
- On a recent project we decided to just treat all of those spaces as fully heated
- The amount of insulation we would have saved turned out to be incredibly small
- The amount of headache we saved was enormous!

Existing buildings

Chapter 5

Additions

- Addition envelope meets current code
- Requires C406 credits
  - Addition alone can comply, or
  - Addition + existing can comply
  - No credits required if smaller than 500 sf
- Fenestration complies if:
  - Addition + existing complies, or
  - UxA calc for addition only, or
  - UxA calc for addition + existing, or
  - C407 for addition only, or
  - C407 for addition + existing

Alterations

- New assemblies comply with code
  - Seattle: U-factor no worse than existing
- Existing can remain as-is
- A few exceptions:
  - Storm windows
  - Framing cavities exposed during construction, if filled with insulation
  - Construction not exposing cavities
  - No air barrier required for “roof recover” or “roof replacement”
  - No vestibule required if replacing existing door in same opening

More alterations

- Air leakage testing not required, except:
  - Substantial alterations
  - Change of space conditioning
  - Change of occupancy
- “Roof replacements” comply with code
  - Where no roof insulation, or
  - Where all existing insulation above deck
  - But “roof recover” not required to comply

Do not accidently trip Sub Alt!

- Substantial Alterations occur when you "significantly extend the useful physical or economic life of the building"
- I have found the definition to be very grey
- With it comes upgrades for both energy and seismic code. And life safety.
- Meet with the city in advance to get a determination on Sub Alt
- You do not want to find out you are sub alt after you submit for permit!

IS YOUR PROJECT A SUBSTANTIAL ALTERATION?

Definition 1: Does your project include repair of significant damage?

A damage ratio of 60 percent or more is considered significant, and SDCI considers the project a substantial alteration. The damage ratio is the cost of the repair work divided by the estimated replacement cost of the building. SDCI Director's Rule 24-2008 provides information for determining the damage ratio for a building.

SDCI generally considers damage from an event to evaluate this definition. Events are things like earthquakes, fires, vehicle impacts, or severe weather. Damage may include deterioration of the building after the event from delayed repairs or maintenance. Routine maintenance is not included in the cost of the repair work.

Definition 2: Does your project extend the useful physical or economic life of a significant portion of the building?

Significant investment in the building extends the useful physical and economic life of the building. To assess the level of investment in the building, SDCI considers additions, upgrades, alterations, and/or replacements to major building systems. The major building systems typically considered include elevators and escalators, electrical, plumbing, mechanical, structural framing, and the building envelope. Both currently proposed and recently permitted work may be considered together to determine whether the project is a substantial alteration.

https://www.seattle.gov/DPD/Publications/CAM/cam314.pdf

Fenestration

- Fenestration area
  - New + existing fenestration area complies, or
  - Addition only (with code official OK), or
  - UxA calc for addition + existing, x 110%, or
  - C407 for addition + existing x 110%, or
  - No increase in existing fenestration area
  - Exception: Upgrade UxA of whole building so that overall building energy use not increased
- Similar rules for skylights
- Area-weighted average U-factors OK for fenestration of same type

Change in space conditioning: HP exception

C505.2 Change in space conditioning. …Spaces undergoing a change in space conditioning alteration shall be brought up to full compliance with this code…

2. Any semi-heated space in accordance with Section C402.1.1.2 that is altered to become conditioned space or any heated but not cooled space that is altered to become both heated and cooled.

EXCEPTIONS:

1. A change in space conditioning does not require full compliance with this code if the existing heated but not cooled space is altered to become both heated and cooled solely by replacement of the existing heating-only HVAC system with an electric heat pump HVAC system, provided that there is no change in the use or occupancy classification of the area served by the HVAC system that would increase the cooling load, and the new system includes a DOAS with energy recovery in compliance with Section C403.3.5.

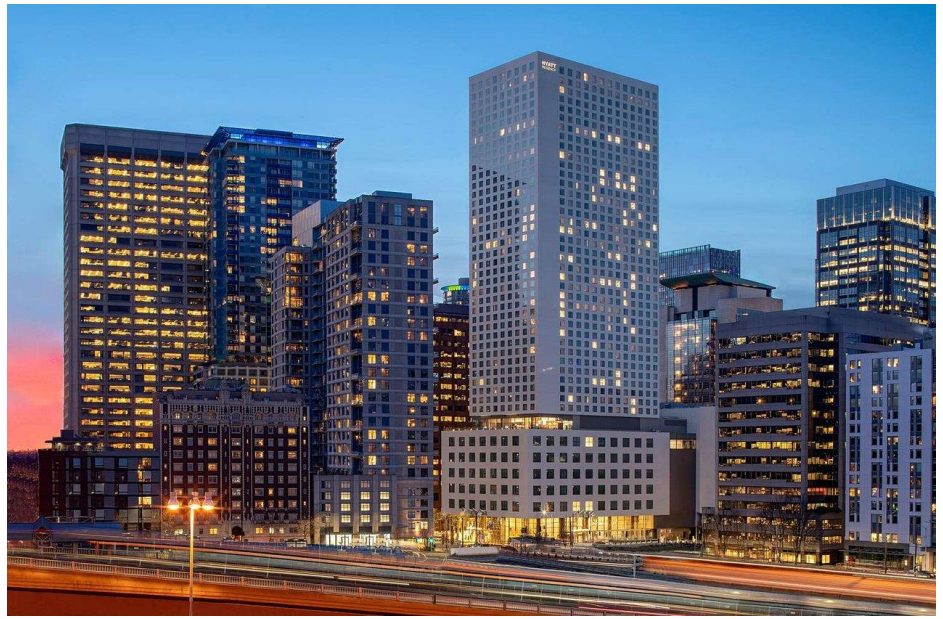
2. The addition of cooling equipment to an already-conditioned floor area of less than 2,000 square feet does not trigger the requirement to comply with this Section 505.2.

WA CBPS & Seattle BEPS

WA "below standard" buildings:

- 50,000 sf threshold (later, 20,000 sf)
- Meet **EUI** target, or
- Progress on approved plan, or
- Pay: $1.00/sf/year penalty
- Starting 2026 – 2028

Envelope improvements (especially fenestration) *might* be economical path



Seattle building CO_2 emissions:

20,000 sf threshold

2030: 39% below 2008 baseline

2050: Zero carbon emissions

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Upcoming 2021 Code Update Deliveries

Webinar Topic	Delivery Date	Time
Lighting and Electrical Issues in the 2021 Energy Codes	February 20	10:00 – Noon
HVAC Requirements in the 2021 Energy Codes	March 20	10:00 – Noon
Service Water Heating Requirements in the 2021 Energy Codes	April 17	10:00 – Noon
2021 Energy Code Requirements for Alterations	May 15	10:00 - Noon

Today's slide deck and video recording can be found on
www.lightingdesignlab.com

Click – Call – Connect

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