

A scenic view of the Seattle skyline from an elevated position, featuring the Space Needle and various skyscrapers. The view is framed by dark green tree branches in the foreground. The sky is a clear, bright blue with some light clouds. The overall atmosphere is bright and clear.

Welcome to the 2021 Codes Envelope

Seattle City Light
Lighting Design Lab
April, 2023

Before we Begin...

During the Webinar

- Attendees will be muted
- Please use the chat feature in the control panel to submit questions to LDL staff
- The presenter will pause to address questions periodically.
- Please participate in the online polls.

Following the Webinar

- Please take the short survey
- A recording and the slide deck will be posted on LDL's webpage
- Reach out to LightingDesignLab@seattle.gov with comments or questions.

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Seattle City Light



2021 Construction Code Changes

- Building code
- Residential code
- Mechanical code
- **Energy code**
- Fuel gas code
- Plumbing code
- Fire code
- Electrical code
- Boiler code



2021 Seattle Energy Code

for “Commercial Buildings” – *not* single-family or townhouse



“2021” Codes

- WA code in effect July 1, 2023
- Seattle code in effect October (?) 2023
- “Commercial buildings” now includes low-rise (1 – 3 story) multifamily

Quick overview, Section C402 – Envelope

Opaque envelope Misc

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

- Table C402.4 Fenestration
 - Seattle “Column A/Column B”
 - C402.4.1 Max glazing area
 - High-perf glazing
 - C402. 4.2 Skylights: Min & max
- C402.4 Doors
- C402.5 Air leakage
 - Testing for dwelling units
- C402.5.9 Vestibules
- C402.5.11 Large openings interlock with HVAC

Fenestration Leakage

It's not *whether* we're going to do this, it's *how*



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

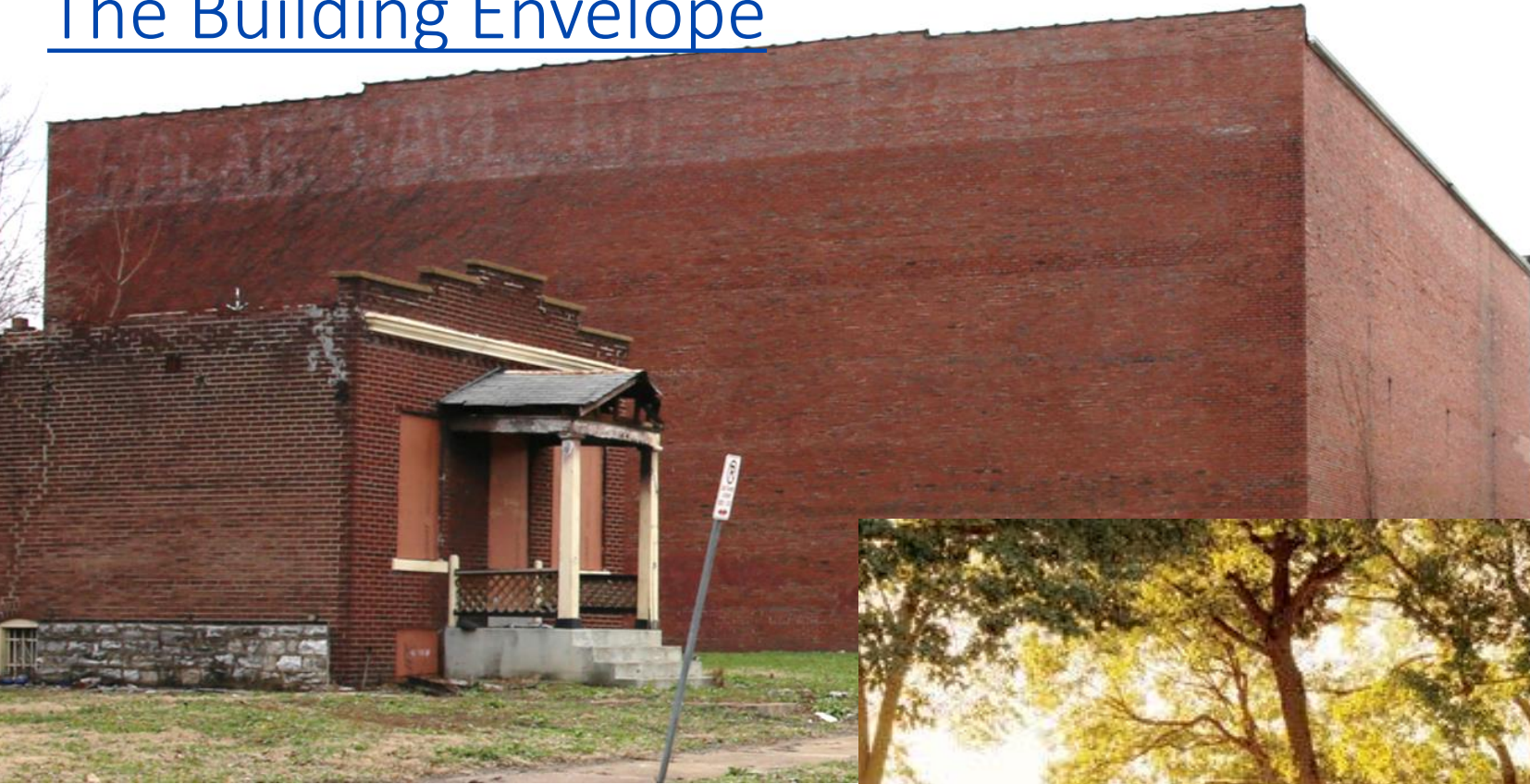
4. Generate power

- Plus “solar readiness” for bigger future system



Build so that no “major surgery” for buildings is required for 2050

The Building Envelope

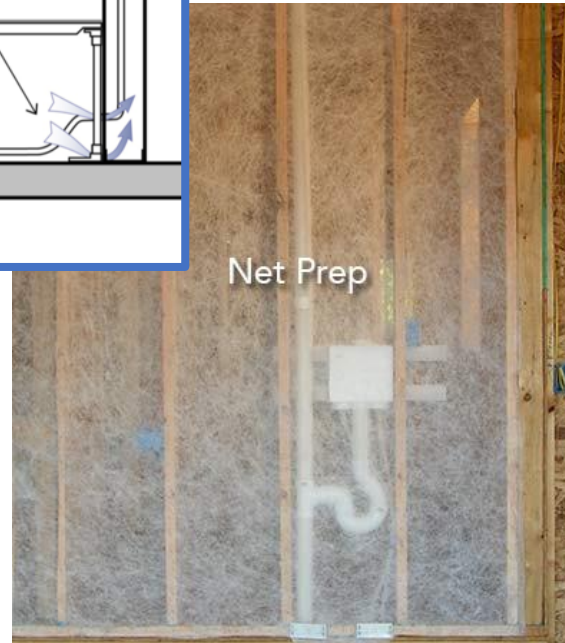
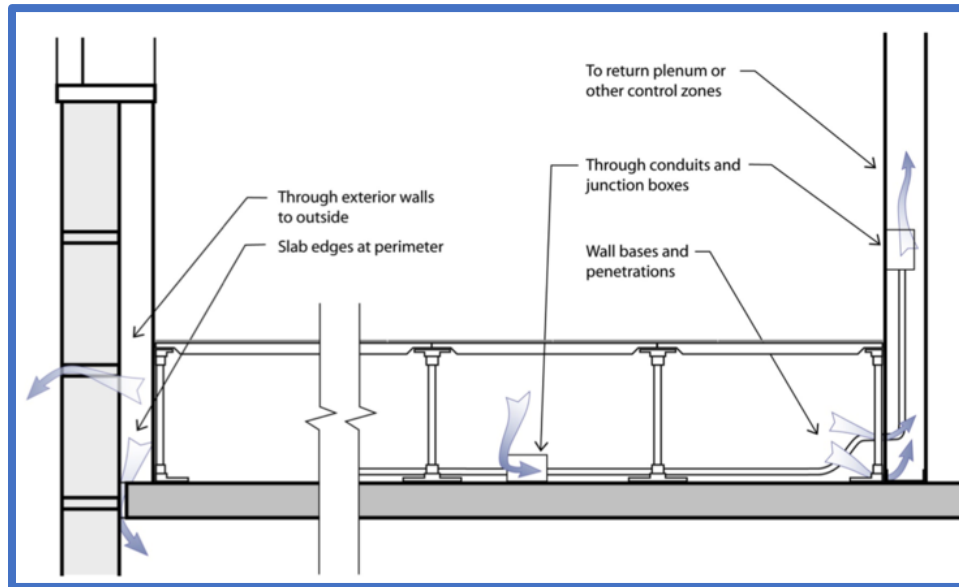


...or Connection?

Separation...



Thermal envelope is boring – and effective



- Reliable energy savings
- Lasts for generations
- ...but invisible

Envelope energy flows

It's mostly about glazing

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

Also:

- + Conduction through assemblies
- + Air leakage through gaps & joints

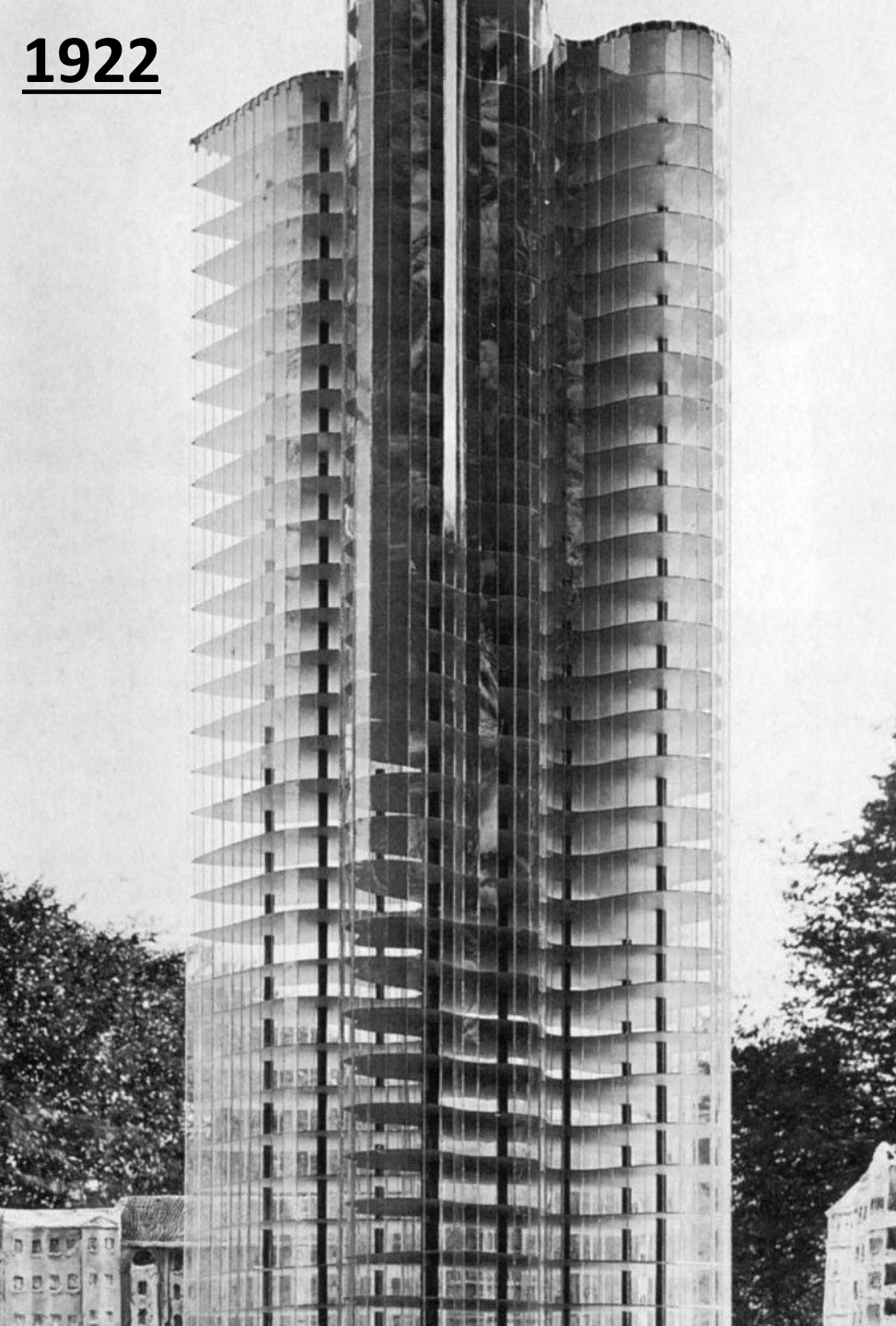


Those older buildings aren't going away

Envelope decisions you make today
will stay with us for a lifetime.
Choose wisely!



1922



How much
glass?

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

2022

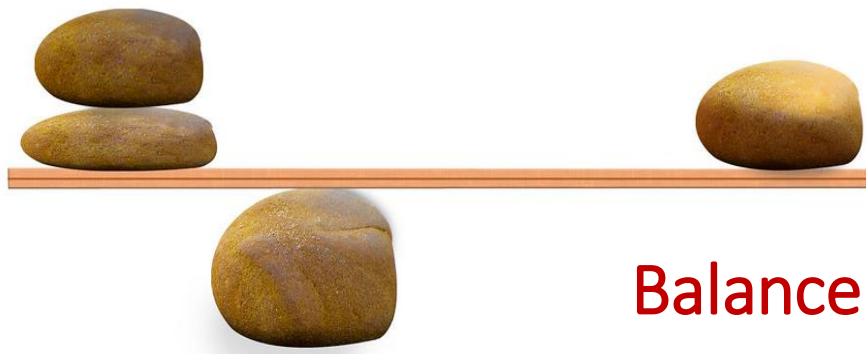


All glass is no longer all beautiful



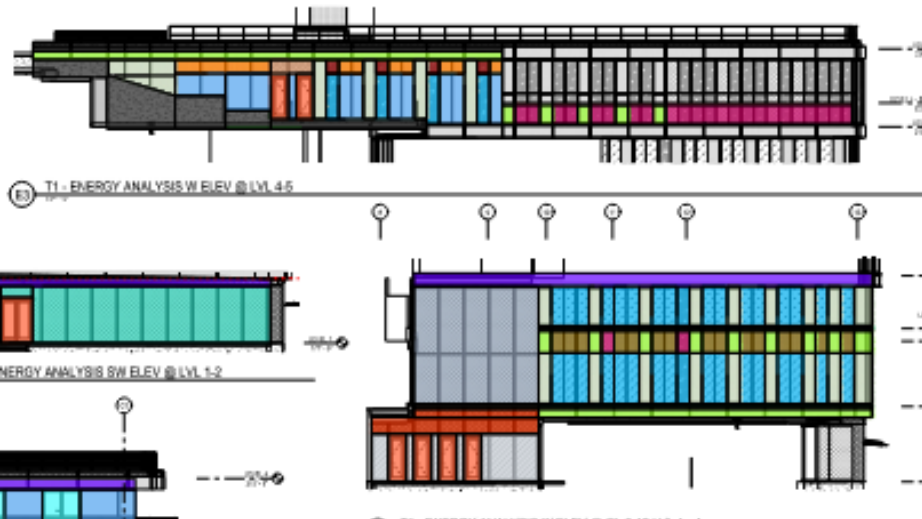
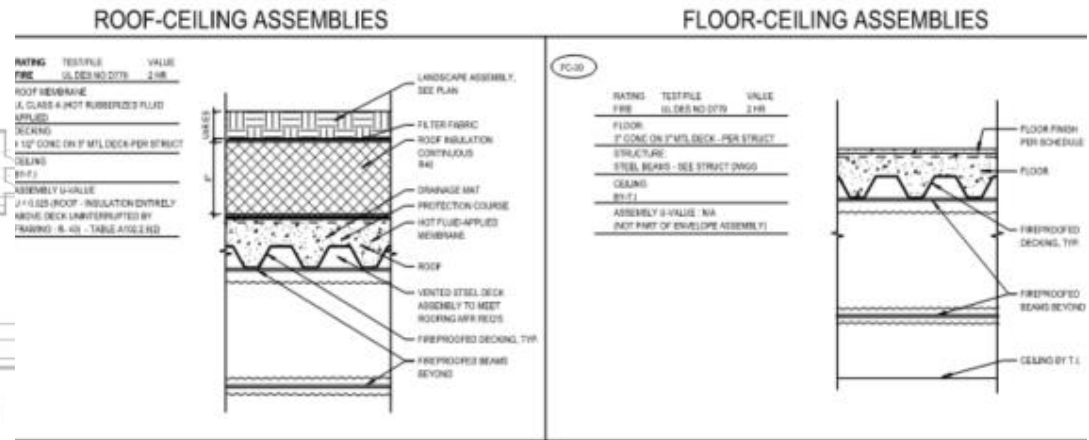
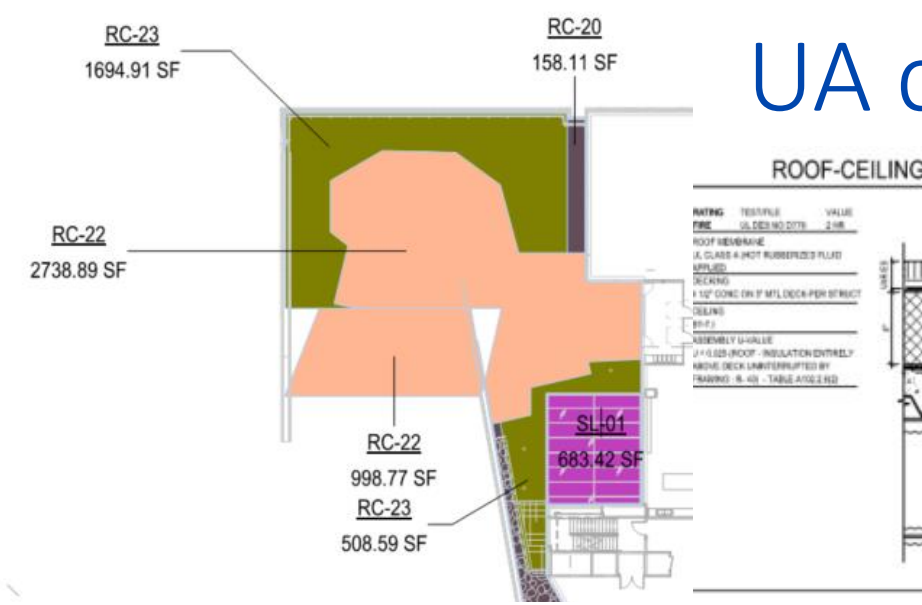
So, what's our optimal 2050 Envelope?

- Passive House?
- Set thermal balance point at 40°F?
 - Maybe at 32°F?
- Use ASHRAE Appendix C?
- 50-year cost effectiveness test, including social cost of carbon?



Question still needs answering:
“How good is good enough?”

UA calculation sucks!



Type	Surface Area SF
T1-WEST PODIUM GLAZED	
WA-1A	1,194 SF
WA-1D	314 SF
WA-1E	1,107 SF
WA-1G	1,236 SF
WA-1H	376 SF
WA-1J	255 SF
WA-1K	188 SF
WA-1L	578 SF
	7,323 SF
OPAQUE	
WA-2A	273 SF
WA-2B	99 SF

2015 WSEC Compliance Forms for Commercial Buildings including R2, R3, & R4 over 3 stories and all R1

Project Title: BELLEVUE 600 PHASE 1 Date: 01/01/2017

Fenestration Area as % gross above-grade wall area: 44.9% Max. Target: 40.0%

Skylight Area as % gross roof area: 3.8% Max. Target: 5.0%

Building Component	Proposed UA		Target UA	
	U-factor	x Area (A)	U-factor	x Area (A)
Sub-on-grade			0.540	
Slab-On-Grade			F-0.54	
Heated Slab-On-Grade			F-0.55	
Doors				
Other				
Non-Metal			0.30	
Non-Metal Frame			U-0.30	
Vertical Fenestration				
WA-1A	0.28	167560	0.38	187915
WA-1B	0.39	24488	0.37	1886
WA-1E	0.33	4355	0.37	1437.2
WA-1G	0.32	8849	0.37	3297.8
WA-1J	0.30	1326	0.37	497.9
WA-1K	0.32	470	0.37	174.7
WA-1L	0.32	931	0.37	346.9
WA-1M	0.32	1468	0.37	523.6
WA-22	0.65	1347	0.65	875.6
WA-1C	0.54	6434	0.40	11971
WA-1D	0.43	6994	0.43	3007.4
WA-1H	0.80	1751	0.60	1561
SL-01	0.42	2104	0.50	2104
Refrigerated Space Freezer Floors				
Freezer Floor				

Area'	UA	Area'	UA
Page 2 Subtotal	229963	72391	205436
Page 1 Subtotal	389503	41170	414030
Project Total	619466	113562	20418

- UA CALCULATIONS ARE EXTREMELY PAINFUL AND TIME CONSUMING.
- WE HAVE BEEN TRYING FOR 20 YEARS TO AUTOMATE AND STILL NO LUCK

Prescriptive fenestration area

WA Code

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.

Single % for everything

Seattle Code

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

% varies per building type

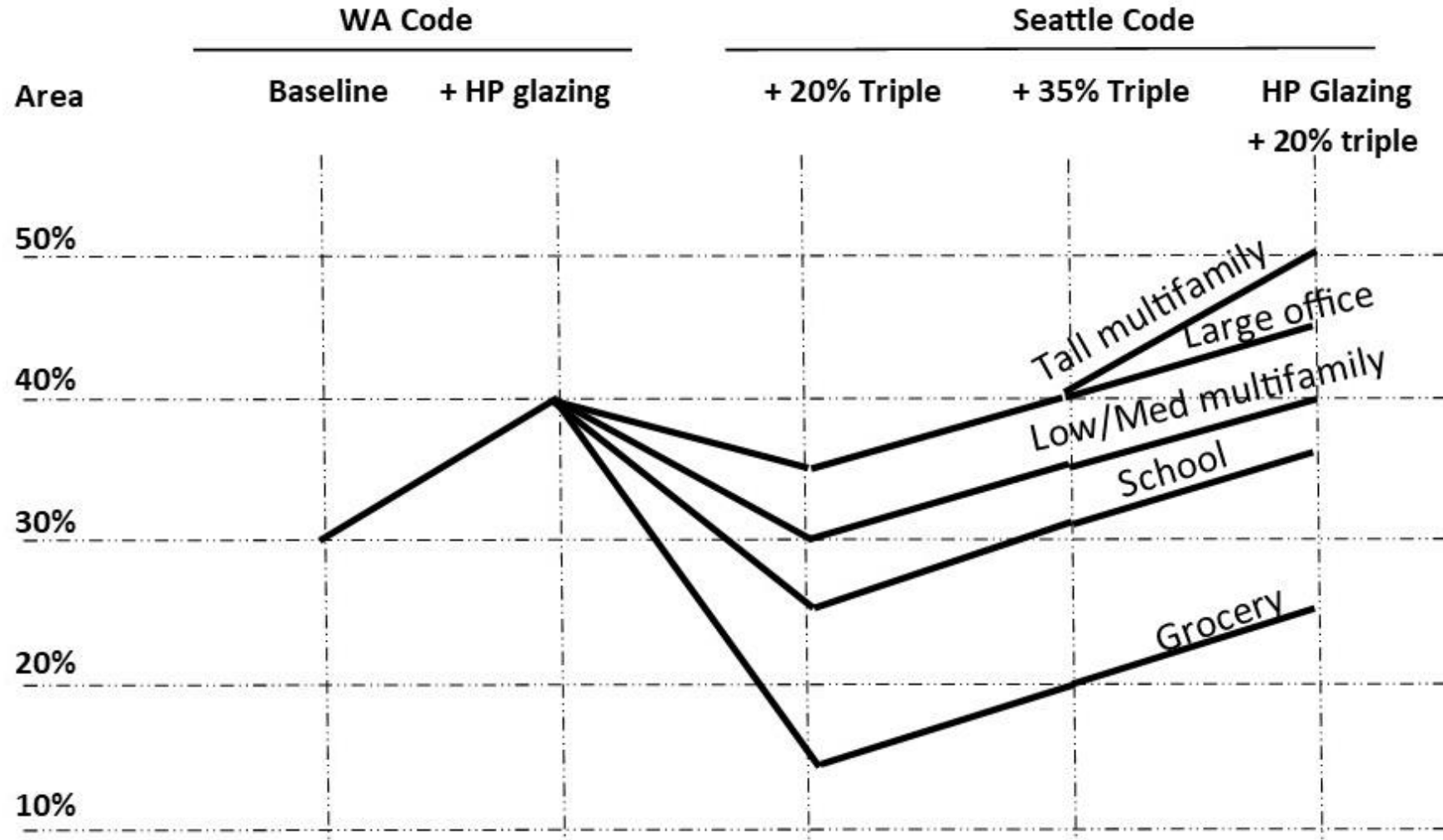
Table C402.4.1

- **Prescriptive** path baseline allowable glazing percentage
- Options available for increased area
- **Energy modelers:** Several ASHRAE Appendix G values are different

Occupancy	Building Area Type	Maximum prescriptive vertical fenestration %
Group A-2 or B	Restaurant (quick service)	34
Group A-2 or B	Restaurant (full service)	24
Group B	Healthcare (outpatient)	21
Group B	Office (Smaller than 5000 ft ²)	19
Group B	Office (5000 to 50,000 ft ²)	31
Group B	Office (larger than 50,000 ft ²)	35
Group B	University or college	30
Group E	School (primary & secondary)	26
Group I-2	Hospital	27
Group M	Grocery Store	15
Group M	Retail (standalone)	20
Group M	Retail (strip mall)	20
Group R-1	Hotel/motel (75 or fewer rooms)	24
Group R-1	Hotel/motel (more than 75 rooms)	34
Group R-2	Multifamily 7 stories or less	30
Group R-2	Multifamily 8 stories or taller	35
Group S-2	Warehouse (non-refrigerated)	6
	<u>All other</u>	<u>30</u>



Allowable fenestration area



For UxA calculations, these are the baseline allowable areas

Fenestration U-factors

Baseline WA & Seattle (Column A)

- 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

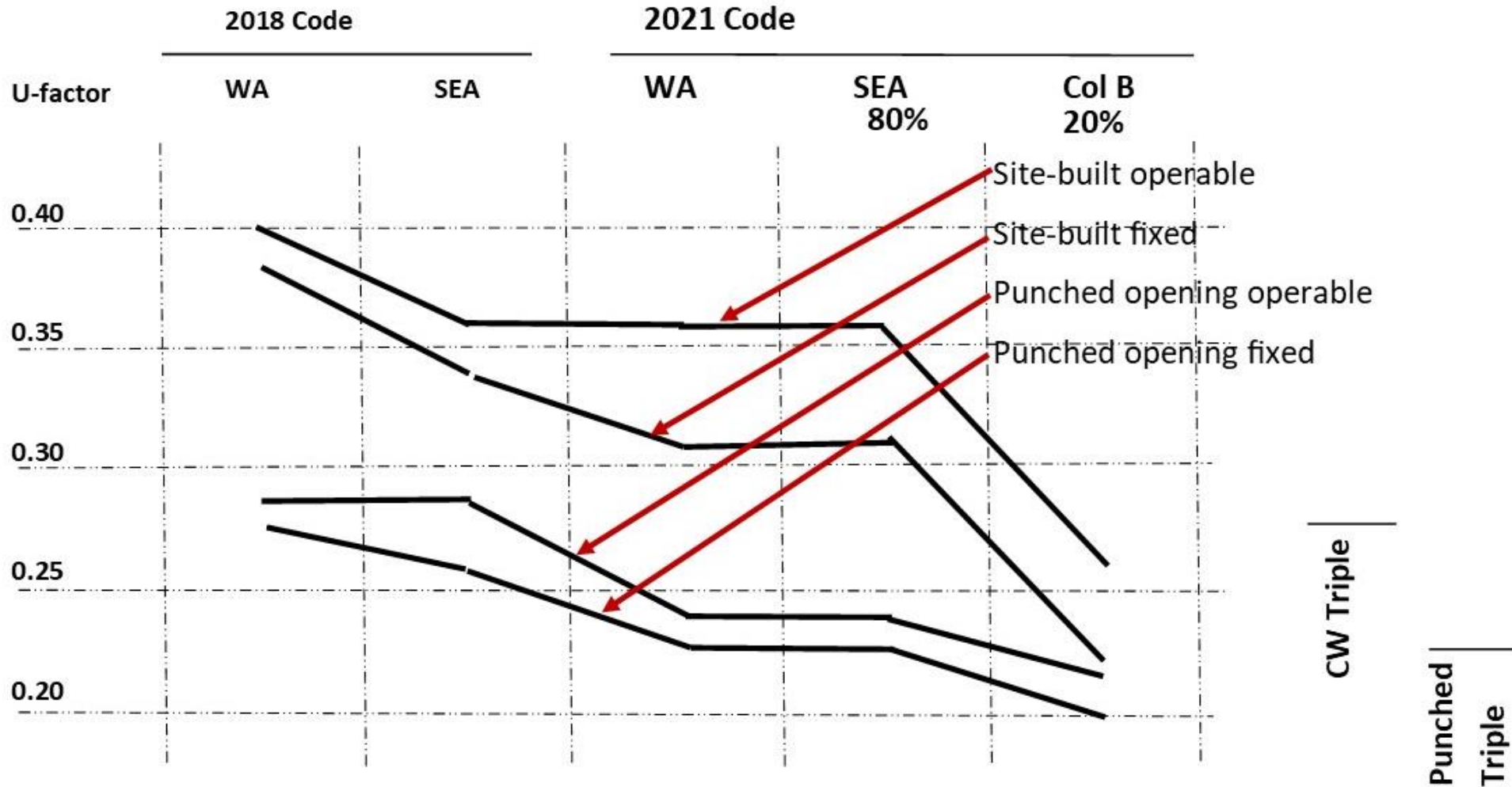
Column B for 20% (or 35%) Seattle

- U-0.22 for curtain wall, storefront, Class AW windows
 - U-0.26 for operable
- U-0.20 for “all other”
 - Mostly punched windows
 - U-0.22 for operable

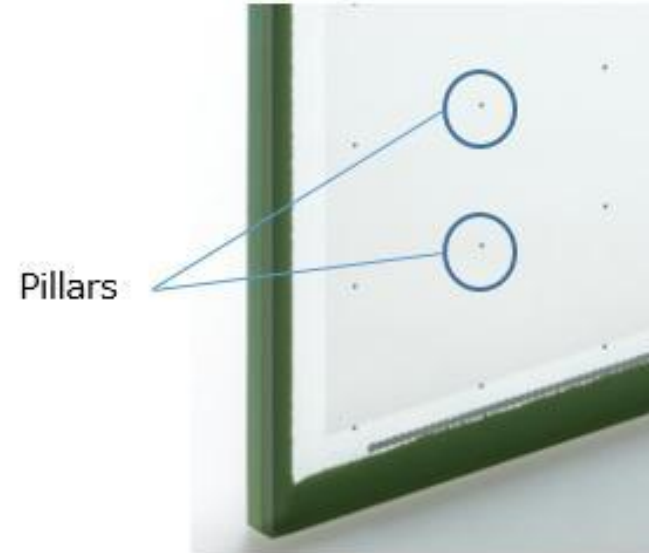
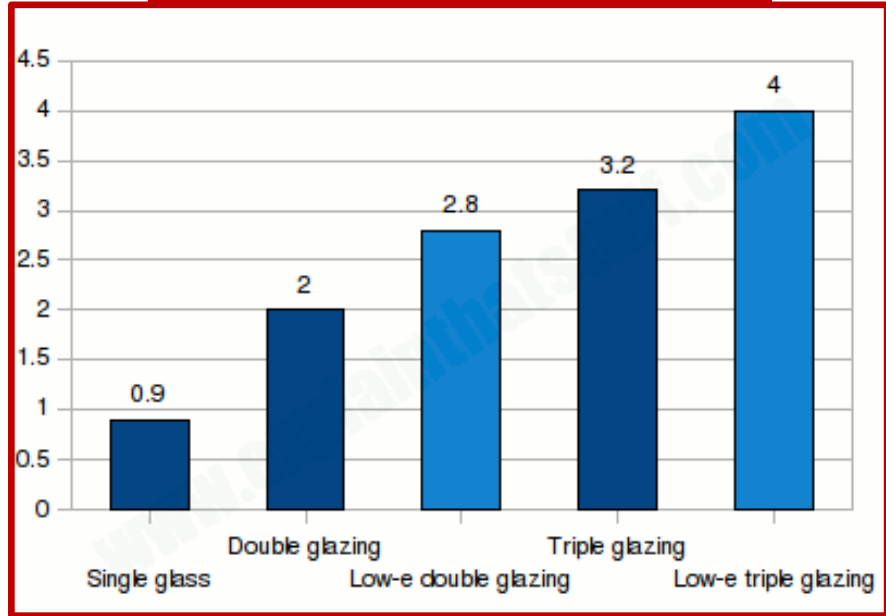
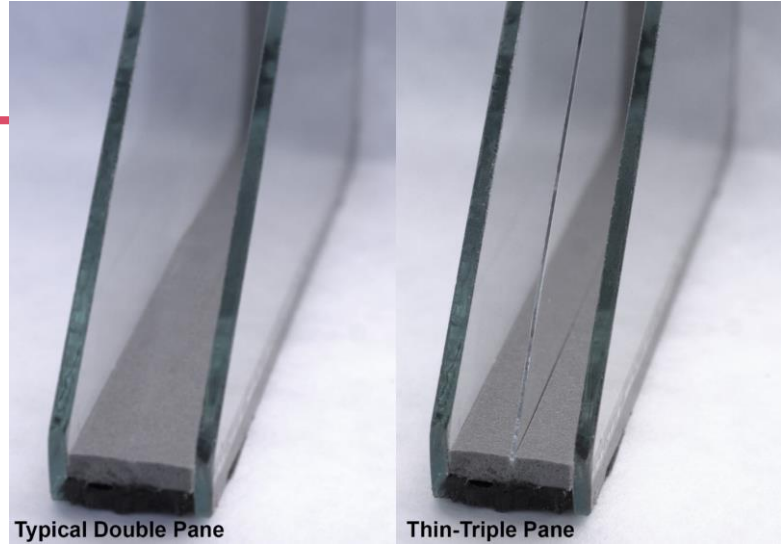
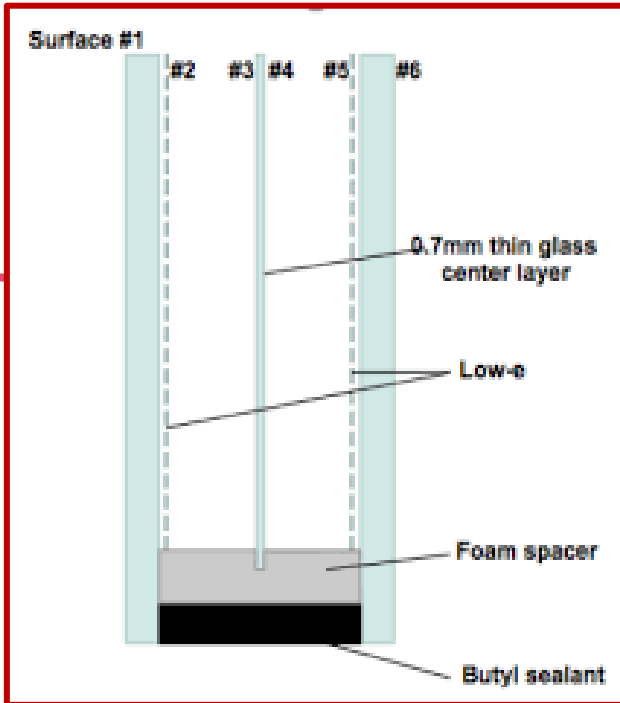
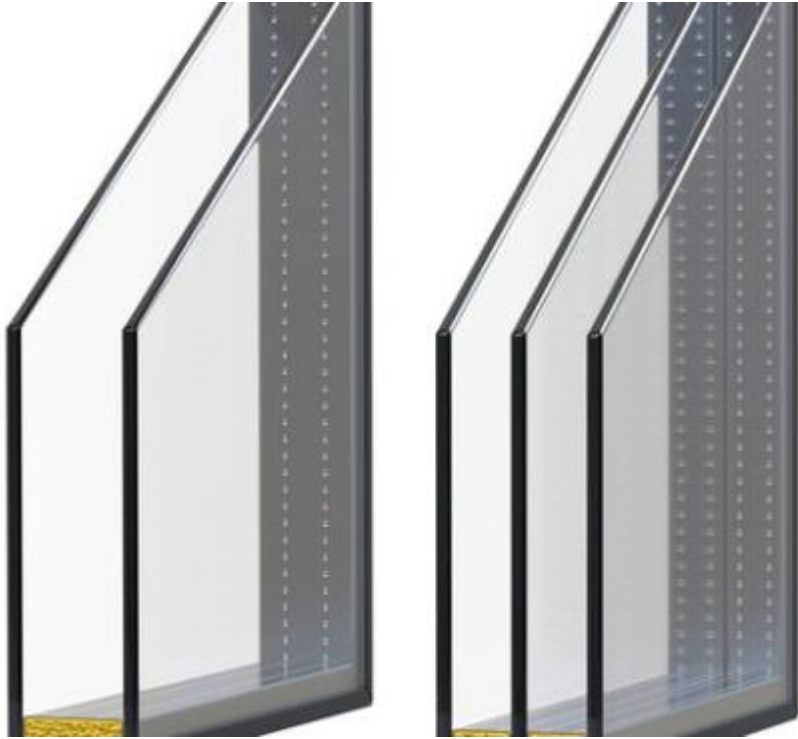
Seattle: 20% of glazing must be triple-pane
(35% with fenestration area bonus)



Fenestration U-factors



Triple glazing alternatives



Cost study of triple glazing: Will your mech engineer believe you?

- Rapidly approaching the point that triple pane pays for itself!
- We are only seeing a 15% premium for triple pane!
- 0.19 U value with a typical system
- Triple glazed IGU
 - VNE-63 on #2 surface
 - VE-85 on #4 surface



High-performance fenestration area

WA Code

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.

40% for everything

Seattle Code

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 the percentage of the total building gross above grade wall area permitted in Table C402.4.1 by 15 percent for Group R-2 multifamily building area types and 10 percent for all other building area types for the purpose of prescriptive compliance with Section C402.1.4. Not less than 20 percent of all vertical fenestration must comply with the Column B values of Table C402.4

Table + 15% for R-2, Table + 10% all other

Seattle: High-performance fenestration U-factors

Column C for 80% (or 65%) of glazing

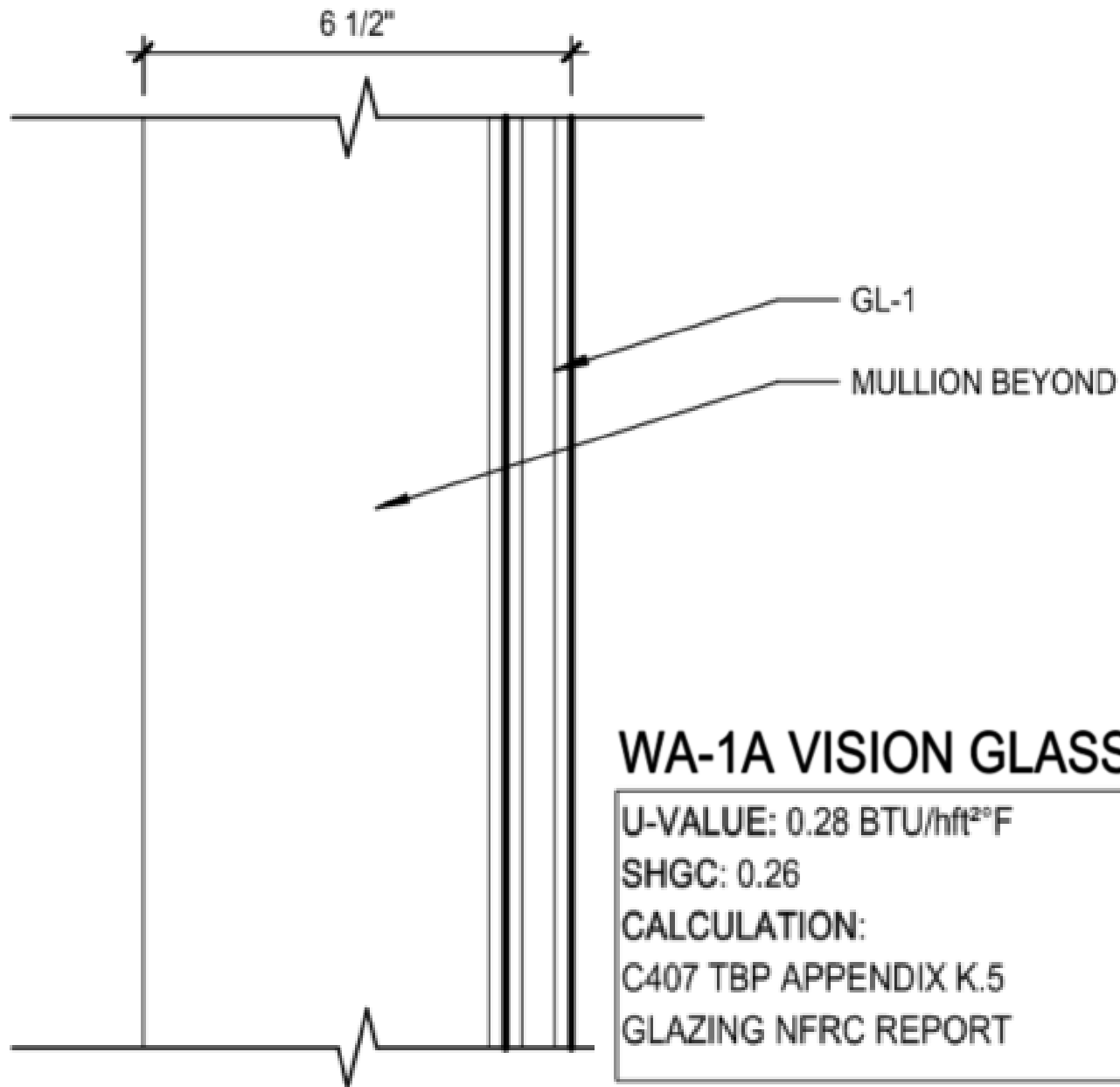
- **U-0.26** (operable 0.30)
 - Site-built (curtain wall, storefront, etc.)
 - Class AW windows
- **U-0.22** (operable 0.23)
 - “All other” vertical fenestration
 - Mostly punched windows

Column D for 20% (or 35%) of glazing, (same as Column B in Table C402.4)

- **U-0.22** (operable 0.26)
 - Site-built (curtain wall, storefront, etc.)
 - Class AW windows
- **U-0.20** (operable 0.22)
 - “All other” vertical fenestration
 - Mostly punched windows

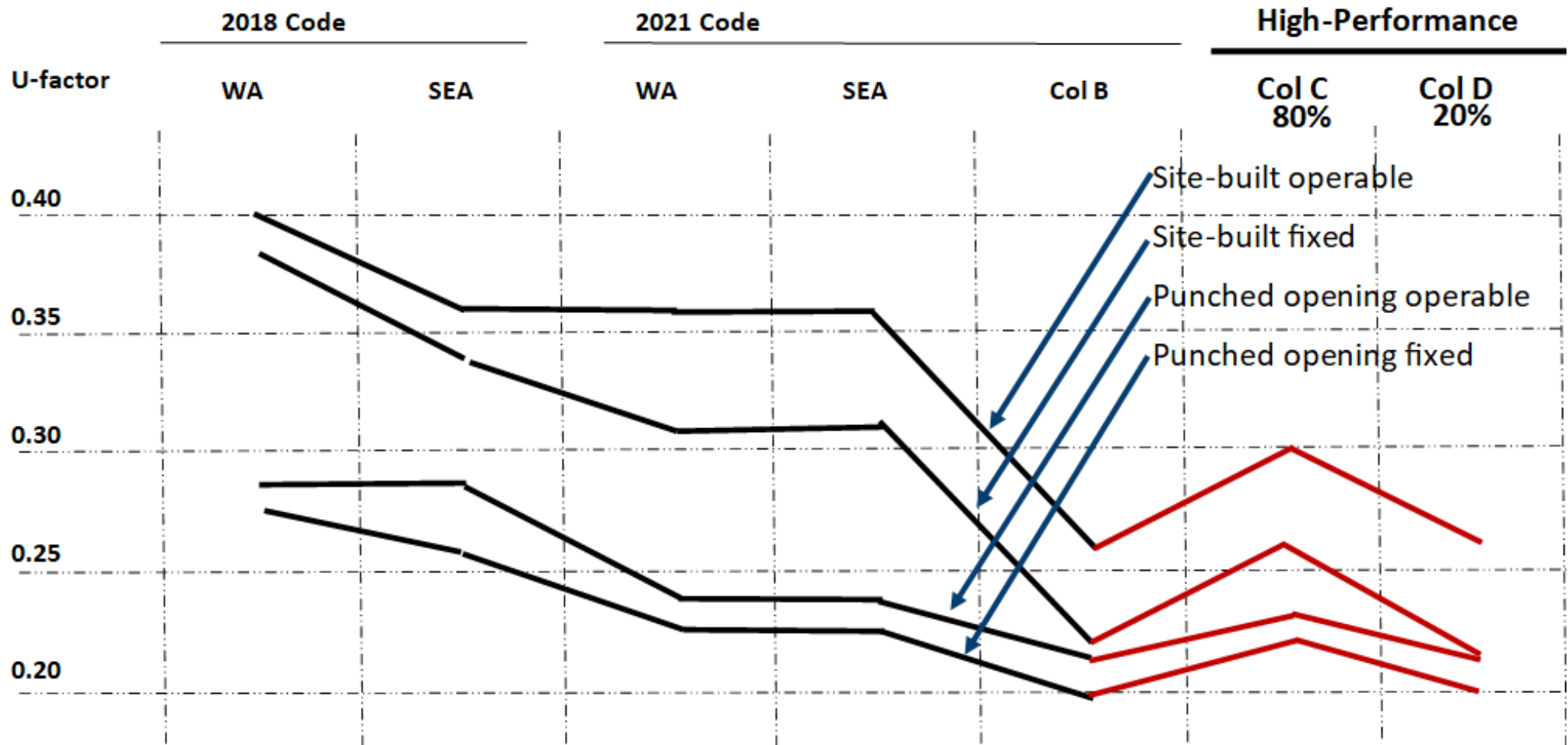
10% more glazing area (15% more for multifamily) for High-Performance glazing
(SHGC values and skylight U-factors remain the same as in standard table)

How hard is this?



- U-0.28 for double pane with low-e #2 & #4 in Plain Jane system
- **This is not hard!**

High-Performance U-Factors



NFRC: Curtain Wall, Storefront...

- NFRC “CMA Bid Report” OK instead of “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
- **Mention label certificates in your specs & pre-bid meetings!**

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·ft ² ·°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

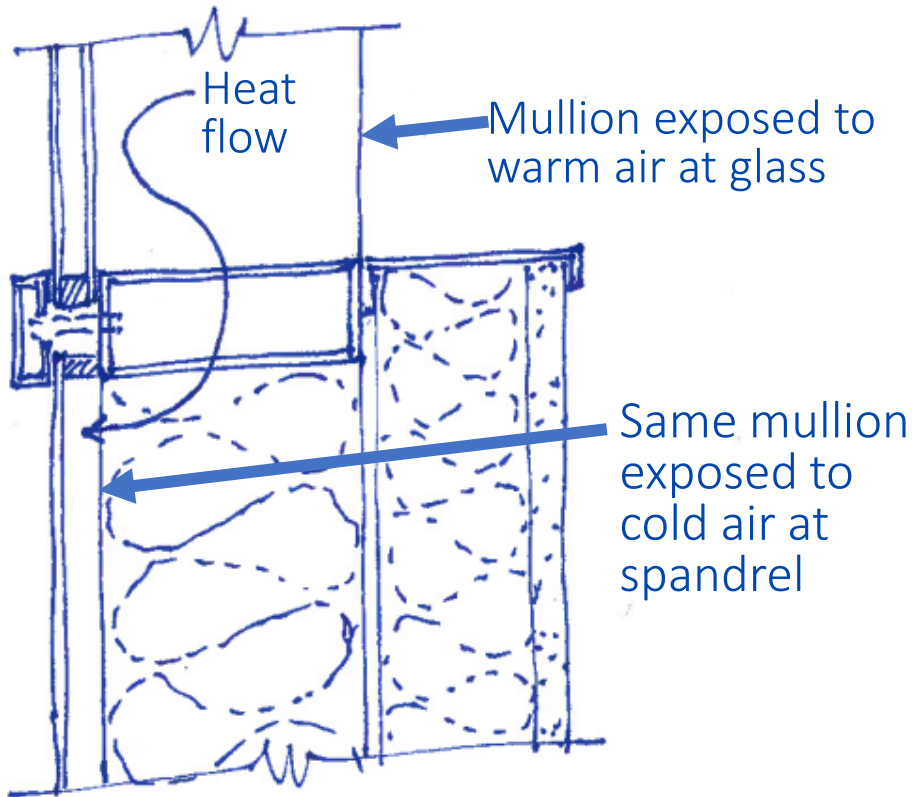


NFRC: Manufactured Windows

- 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

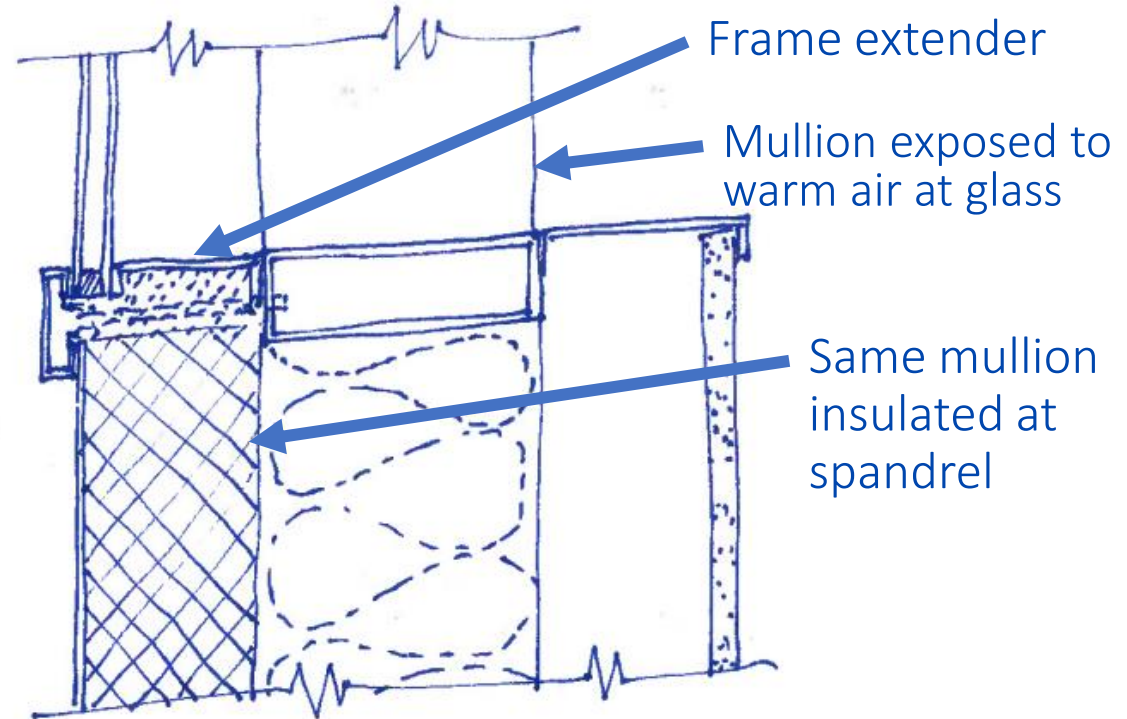
 National Fenestration Rating Council CERTIFIED	Okna Windows & Doors 215-788-7000 DH500dx Welded Double Hung Insul-Tec DeLuxe (DH500dx) Vinyl Foam-Filled Replacement Frame • 34" Insulated Glass Unit • Low-E High Perf. Glass with Argon Gas Vertical Slider Window
ENERGY PERFORMANCE RATINGS	
U-Factor (U.S./I-P) A 0.25	Solar Heat Gain Coefficient B 0.30
ADDITIONAL PERFORMANCE RATINGS	
Visible Transmittance C 0.55	—
<small>Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information www.nfrc.org</small>	

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



Traditional Curtain Wall

The heat loss superhighway

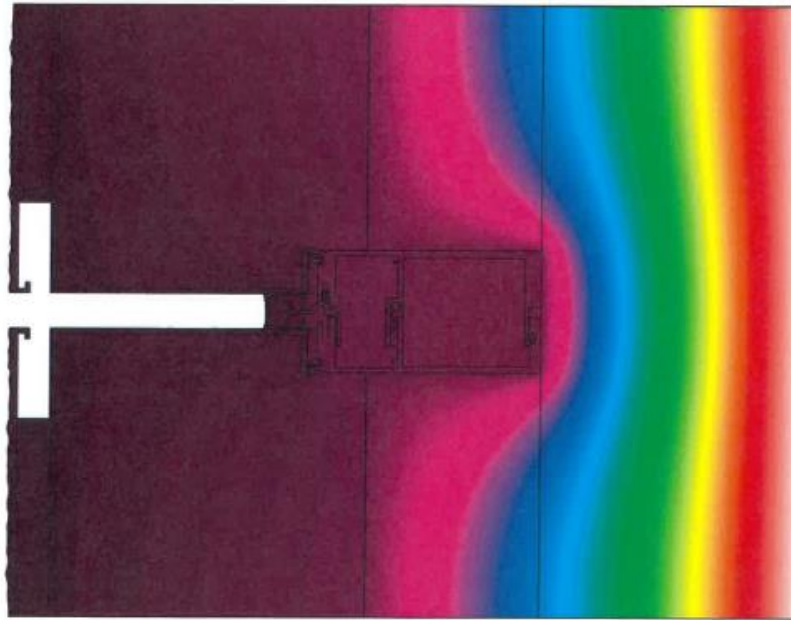


Improved Curtain Wall

Condensation Risk with more insulation is Real!

DEWPOINT TEMPERATURE ANALYSIS: TEMPERATURE DISTRIBUTION PLOT

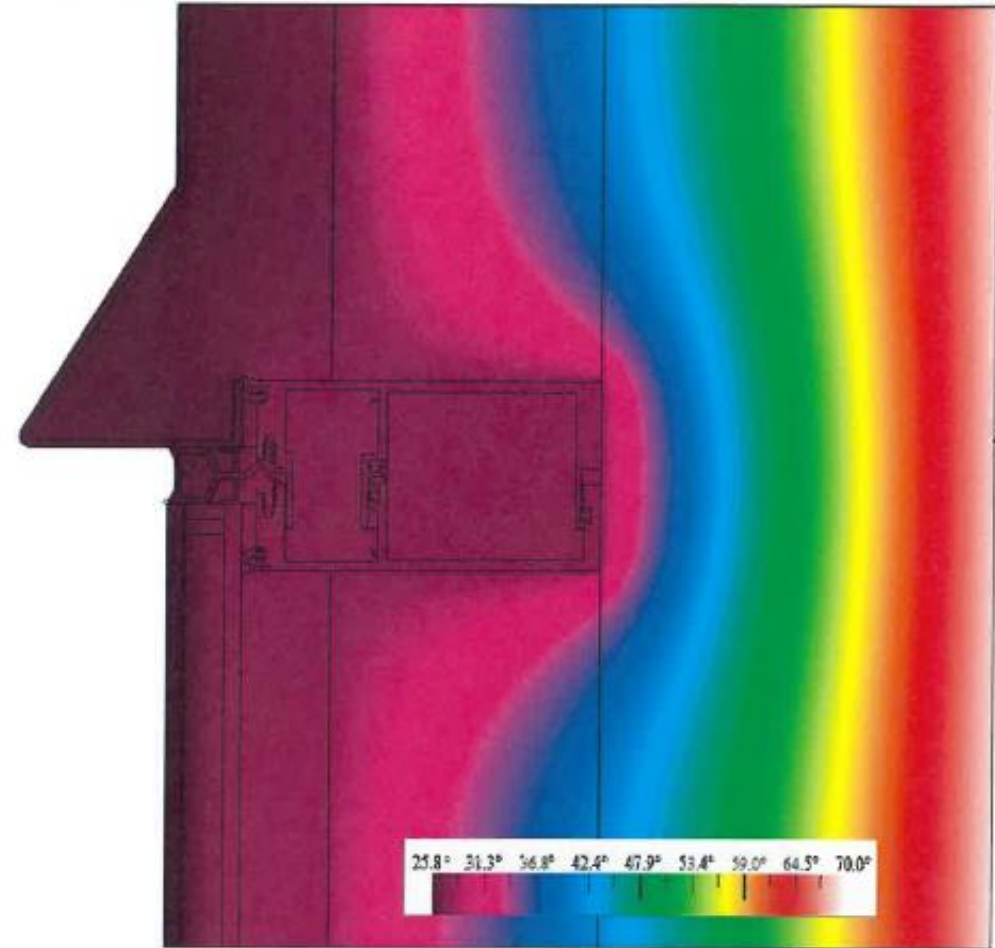
Cross Section	2/656
Exterior Air Temperature	25.8°F
Interior Air Temperature	70°F
Relative Humidity	36% RH
Exterior Wind Velocity	15 mph



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

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.

The requirement in Section C402.4 for 20 percent of fenestration to be high-performance, or 35 percent for compliance with Exception 1 to Section C402.4.1, shall be maintained and that fenestration is not permitted to have a U-factor higher than permitted by Section C402.4.

Seattle: You still must make 20% (or 35%) of your glazing triple-pane

Vestibules: They don't have to be ugly

- 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!



Thermal bridging - Seattle

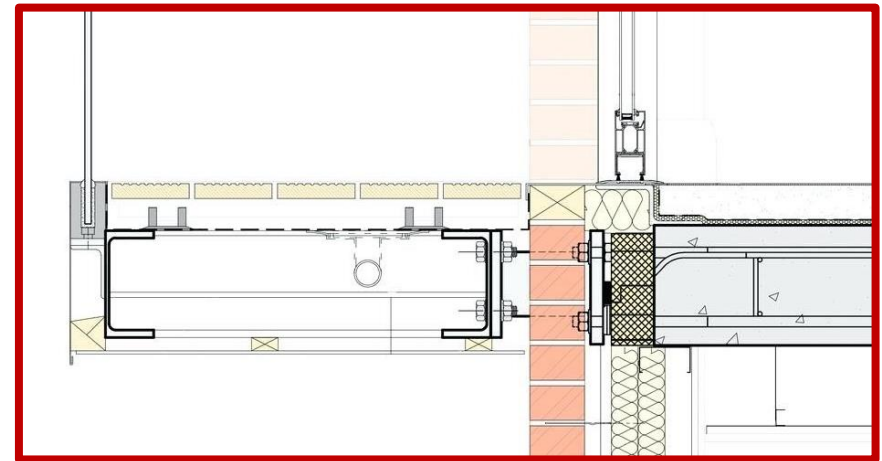
- Concrete balcony C402.2.8
 - Provide R-10 thermal break
 - Stainless steel re-bar penetrations OK
 - Or component performance (target UA)
 - If concrete slab is continuous through wall, use “exposed concrete” in table (U-0.741 for 8” slab)
- Fenestration frame C402.2.9
 - Align continuous insulation & thermal break within 2” of glass plane
 - Insulate “exposed” rough opening to R-3



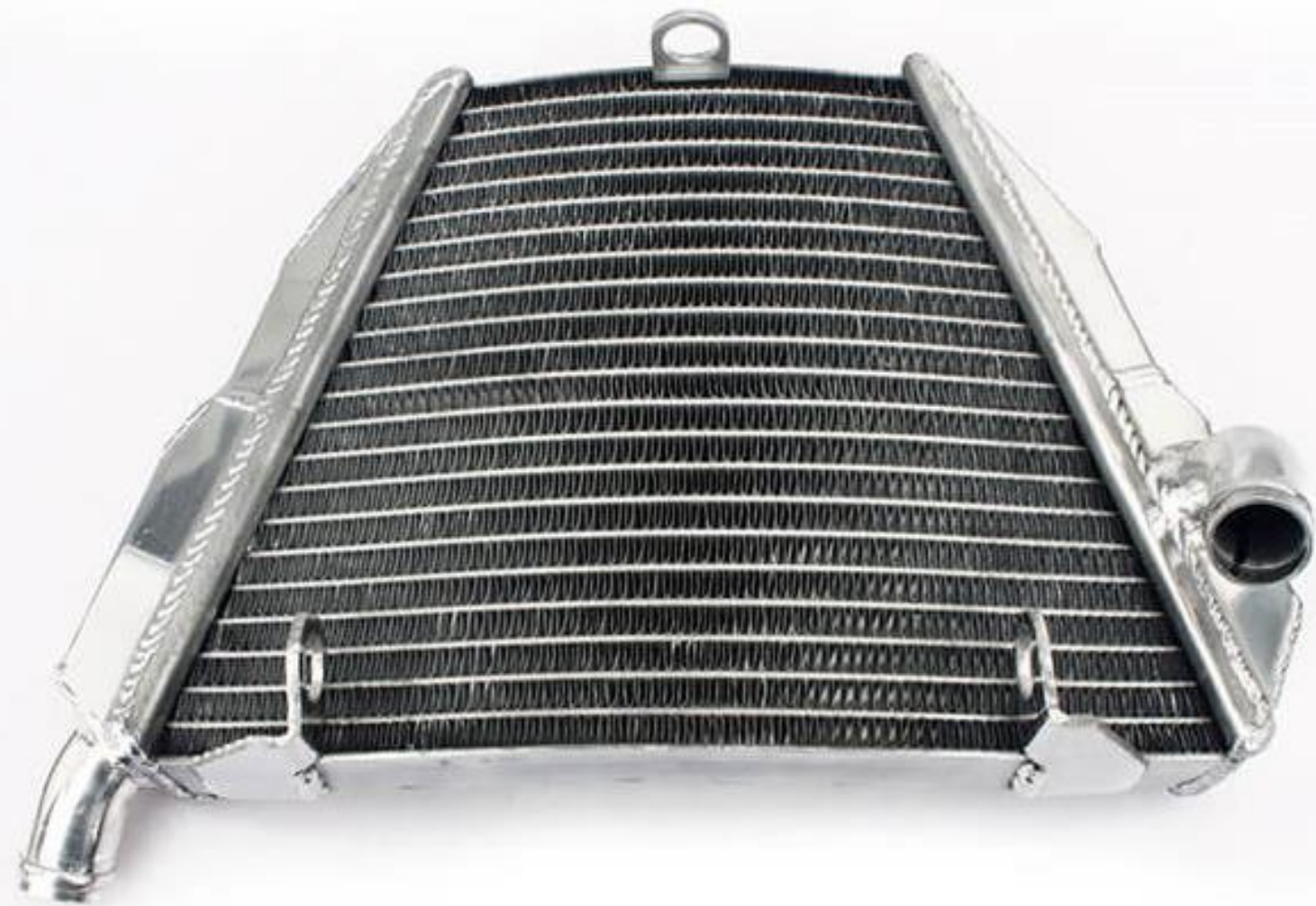
C402.2.8 Concrete balconies

Above-grade concrete slabs that penetrate the *building thermal envelope*, including but not limited to decks and balconies, shall each include a minimum **R-10 thermal break**, aligned with the primary insulating layer in the adjoining wall assemblies. Stainless steel reinforcing bars are permitted to penetrate the thermal break.

If the component performance alternative in Section C402.1.5 is utilized and the thermal break required by this section is not provided where concrete slabs penetrate the building thermal envelope, the sectional area of the penetration shall be assigned the **default U-factors** from the “exposed concrete” row of Table A103.3.7.2. (**U-0.741** for an 8” slab)

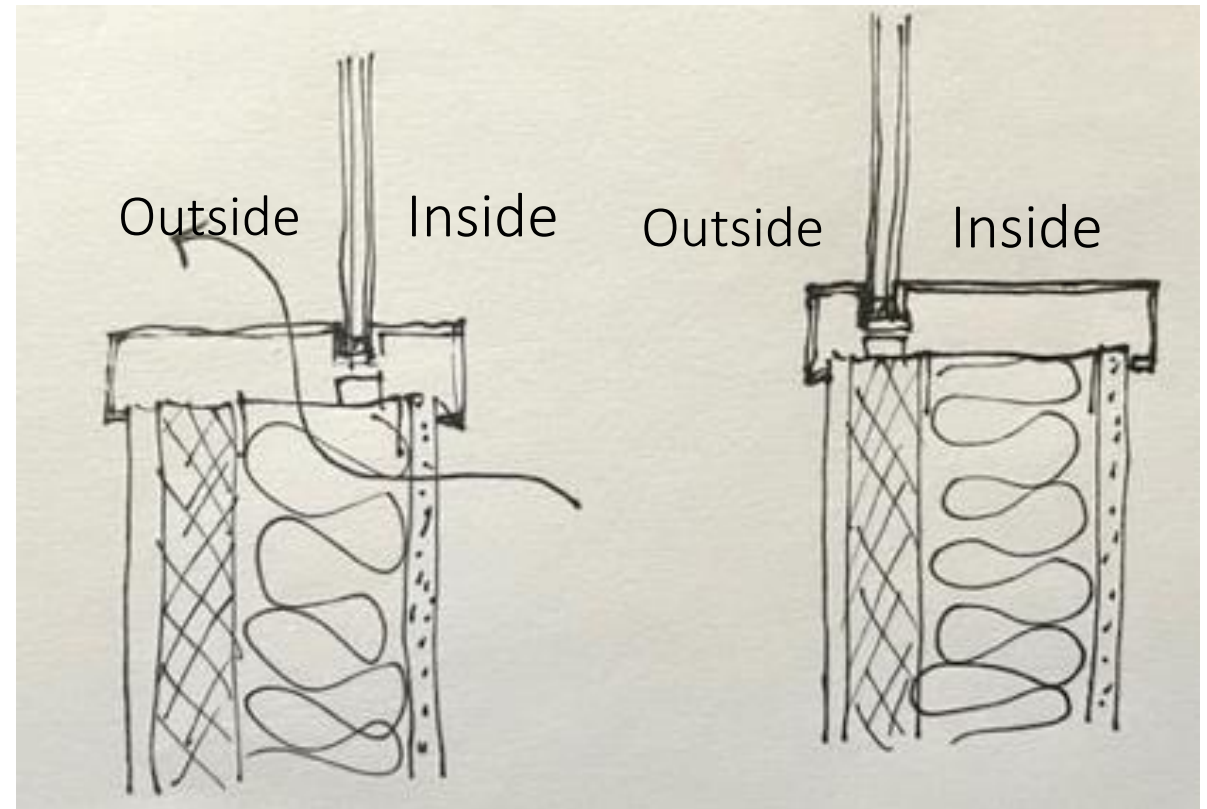
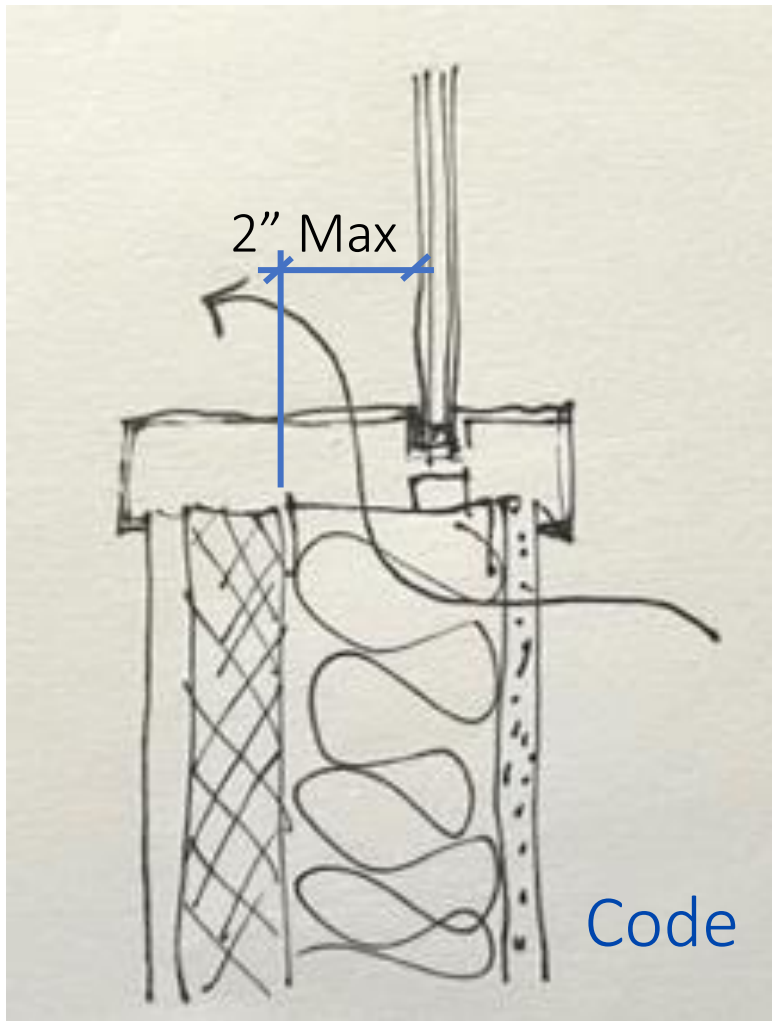


Efficient Heat Dissipation!





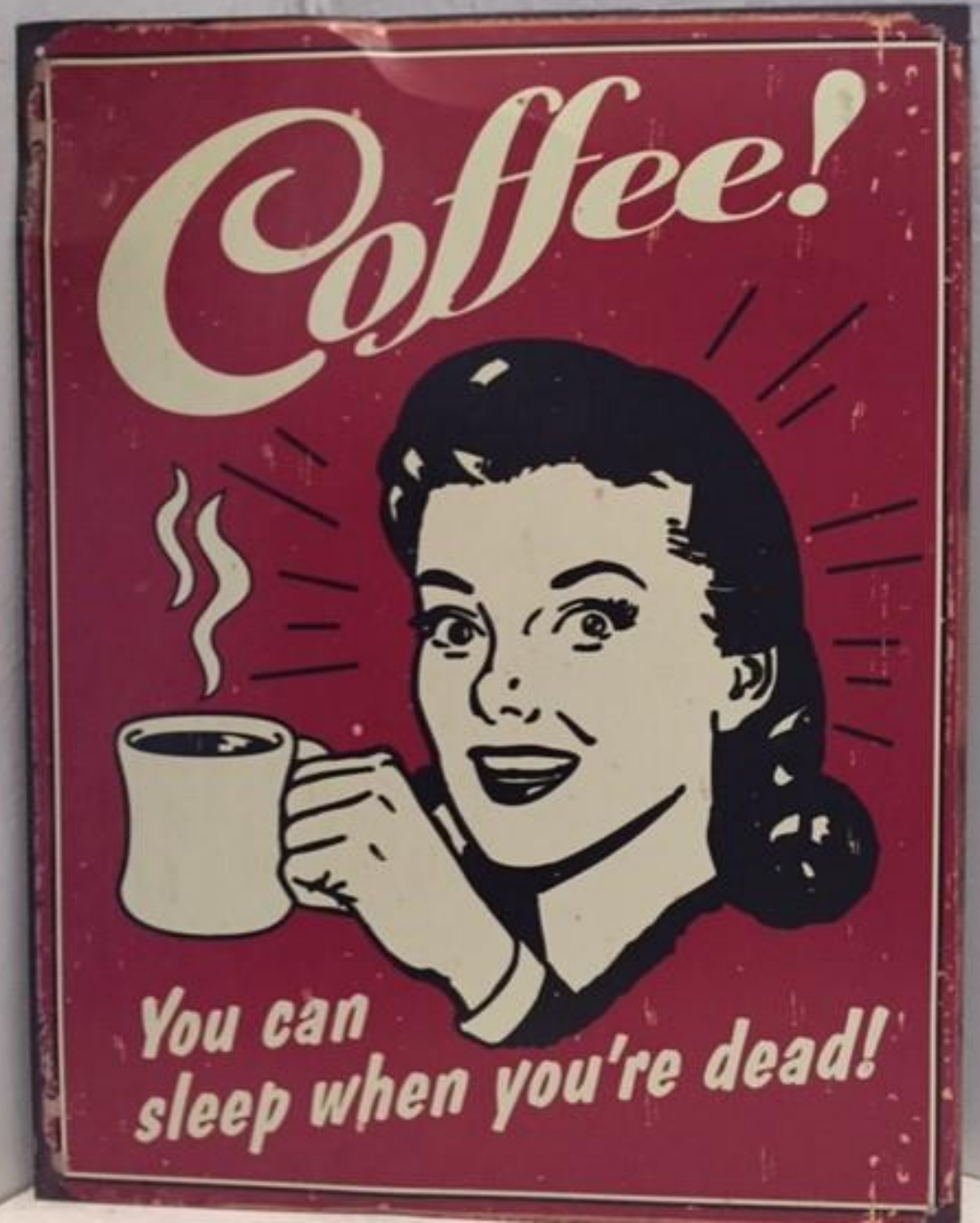
but, we architects just love that “shadow line”



Offset

Aligned

Break Time!

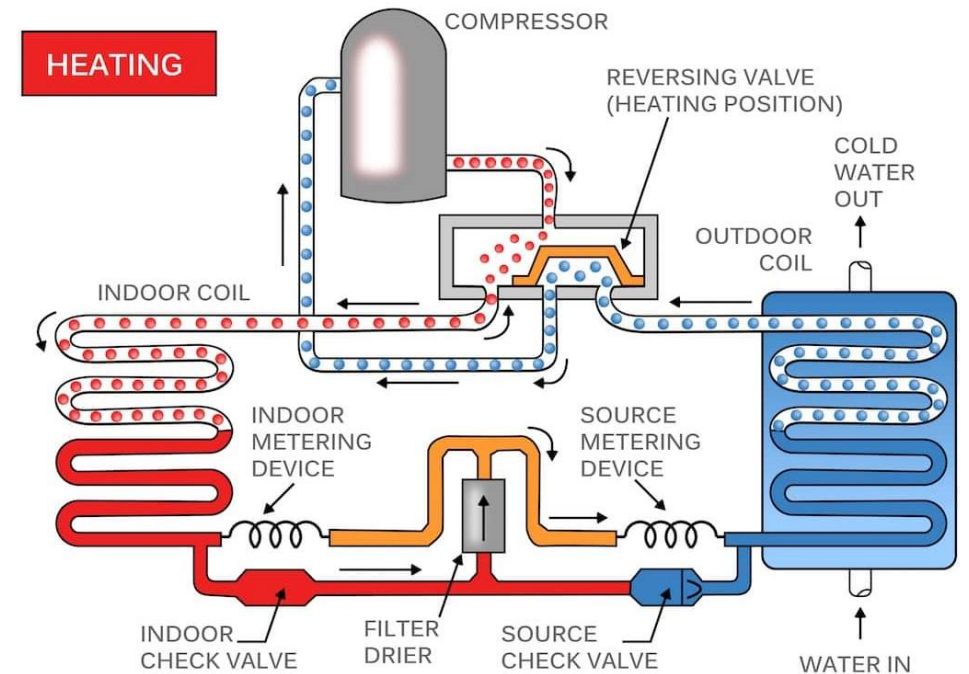


Heat pump space heating: Now in WA code

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



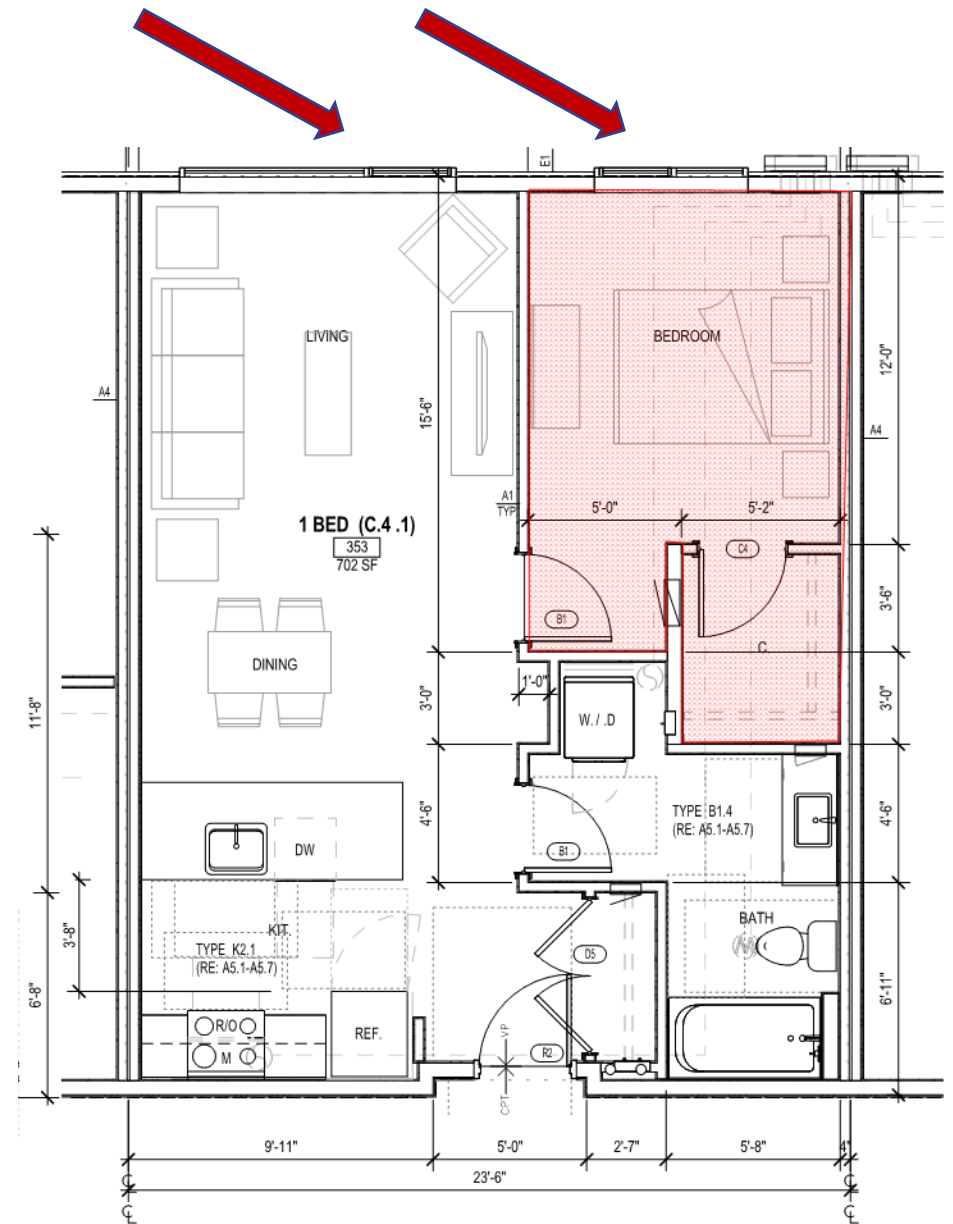
Heat pumps squeeze warmth out of cold air

What envelope design allows 750W?

Electric Resistance Case Studies

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

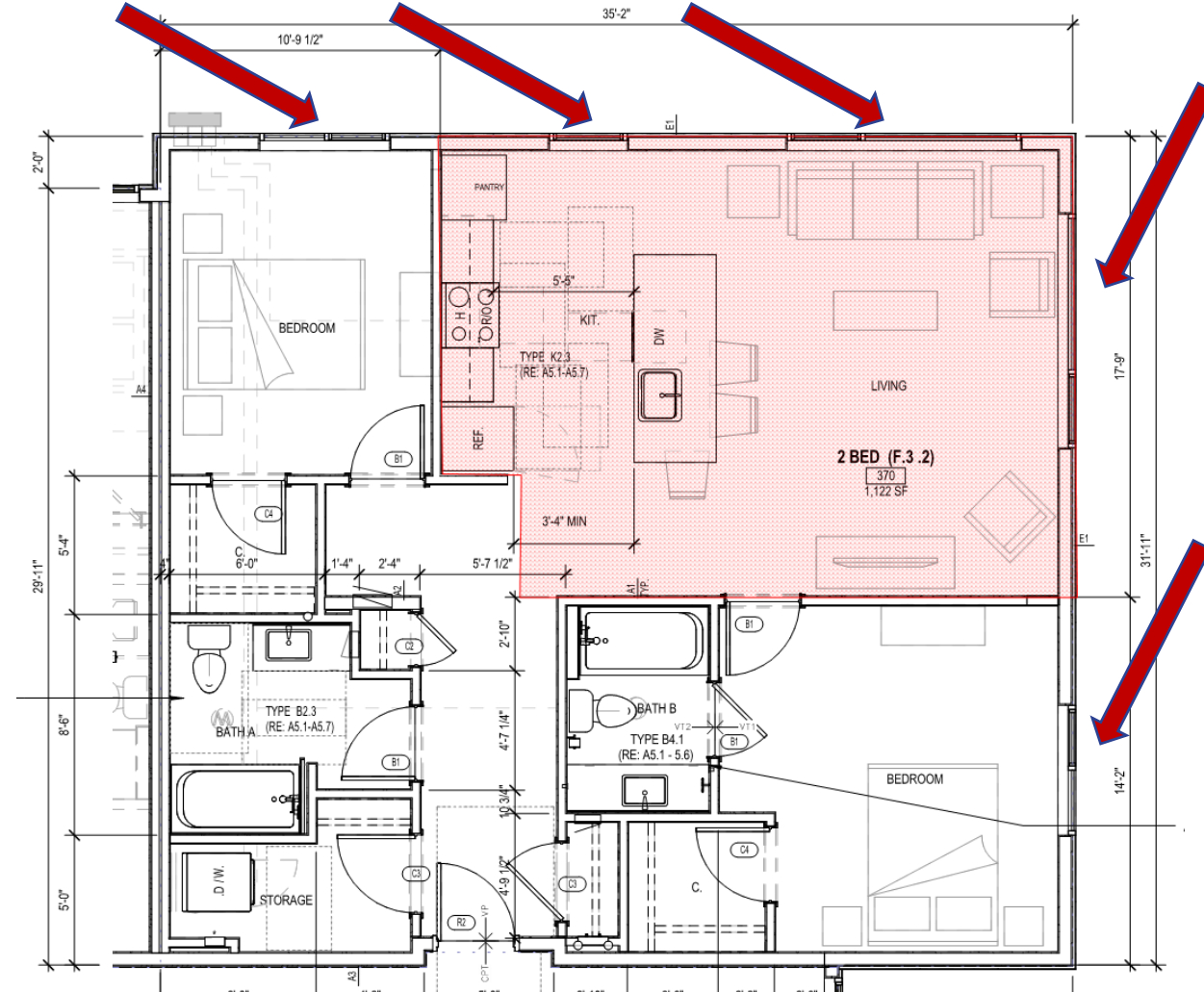
- Typical Bedroom <750W.
- One large (6'x7') sliding glass door (40% glazing).
 - Wood-Framed Construction with punched windows
 - Heat Capacity \approx 400W
 - Steel-Framed Construction with unitized glazing
 - Heat Capacity \approx 475W
- Takeaway: Large glazing % still possible for small rooms with 10-12 feet of exterior wall
- **Will be even easier to meet with 2021 code values**



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 $\approx 1000W$
 - Steel-Framed Construction with unitized glazing
 - Heat Capacity $\approx 1200W$
 - Decrease glazing u-value to **U-0.30** to reduce heating capacity to 1 kW
- Takeaway: It may be challenging to meet loads in corner units due primarily to higher enclosure areas. Close review required
- These are small capacities!
- **2021 code baseline U-factors lower: easier to meet heating load with 750/1000 W**



R-2: Envelope vs. Balanced ventilation/HRV

1. Individual HRV in each apartment?

- Many small penetrations
- Seasonal maintenance in each unit

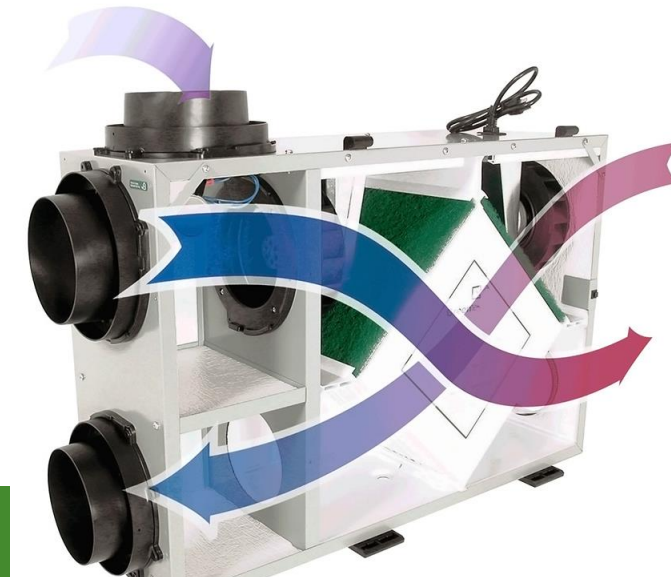
2. Rooftop units with vertical shafts?

- Shafts consume rentable floor area
- Fire dampers
- Competes with other rooftop uses
- Problems with stack effect

3. Floor-by-floor HRVs?

- Each serving 6 – 8 units
- Fewer penetrations
- Easier maintenance

- Deliver ventilation air directly to each “habitable space”
 - Living room, bedrooms
 - **Trickle vents & bathroom exhaust doesn’t work anymore**
- Heat recovery required
 - 67% sensible heat recovery

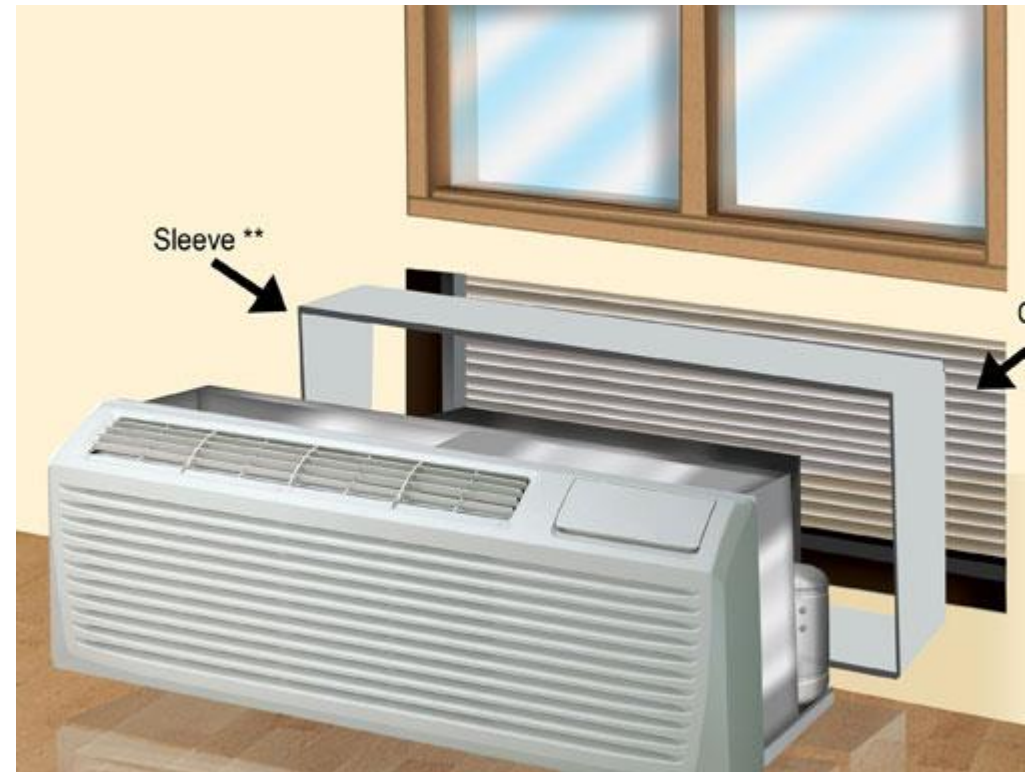


PTAC/PTHP: recognize thru-wall heat loss (now also in WA code)

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 ft² = 15' x 9' wall area
7 ft² = PTHP = 5% of area



Through-wall mechanical equip (PTAC/PTHP)

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

Walls, Above Grade		
Mass^{g,k}	((U-0.104^d)) <u>U-0.057</u>	((U-0.078)) <u>U-0.057</u>
Mass transfer deck slab edge ⁱ	U-0.20	U-0.20
<u>Slab penetrating thermal envelope wall^h</u>	<u>U-0.10</u>	<u>U-0.10</u>
Metal building^k	U-0.052	U-0.052
Steel framed^k	U-0.055	U-0.055
Wood framed and other^k	((U-0.054)) <u>U-0.051</u>	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 (& now WA) Special case U-values

- 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.
- i. 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.

<u>Walls, Above Grade</u>		
Mass ^{g,k}	((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 ^g	U-0.10	U-0.10
Metal building ^k	U-0.052	U-0.052
Steel framed ^k	U-0.055	U-0.055
Wood framed and other ^k	U-0.051	U-0.051
<u>Floors</u>		
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 an electrical utility vault	N.R.	N.R.

Air Barrier Testing (WA & Seattle)

- Test standard is 0.25 cfm/sf of envelope area
- Passing test at 0.25 is mandatory
- Either test the whole building,
 - Or all stories “under a roof,” stories with entrance, loading dock, exposed floor, below grade...
 - ...plus 25% of above-grade walls



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

Make air movement "visible"

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

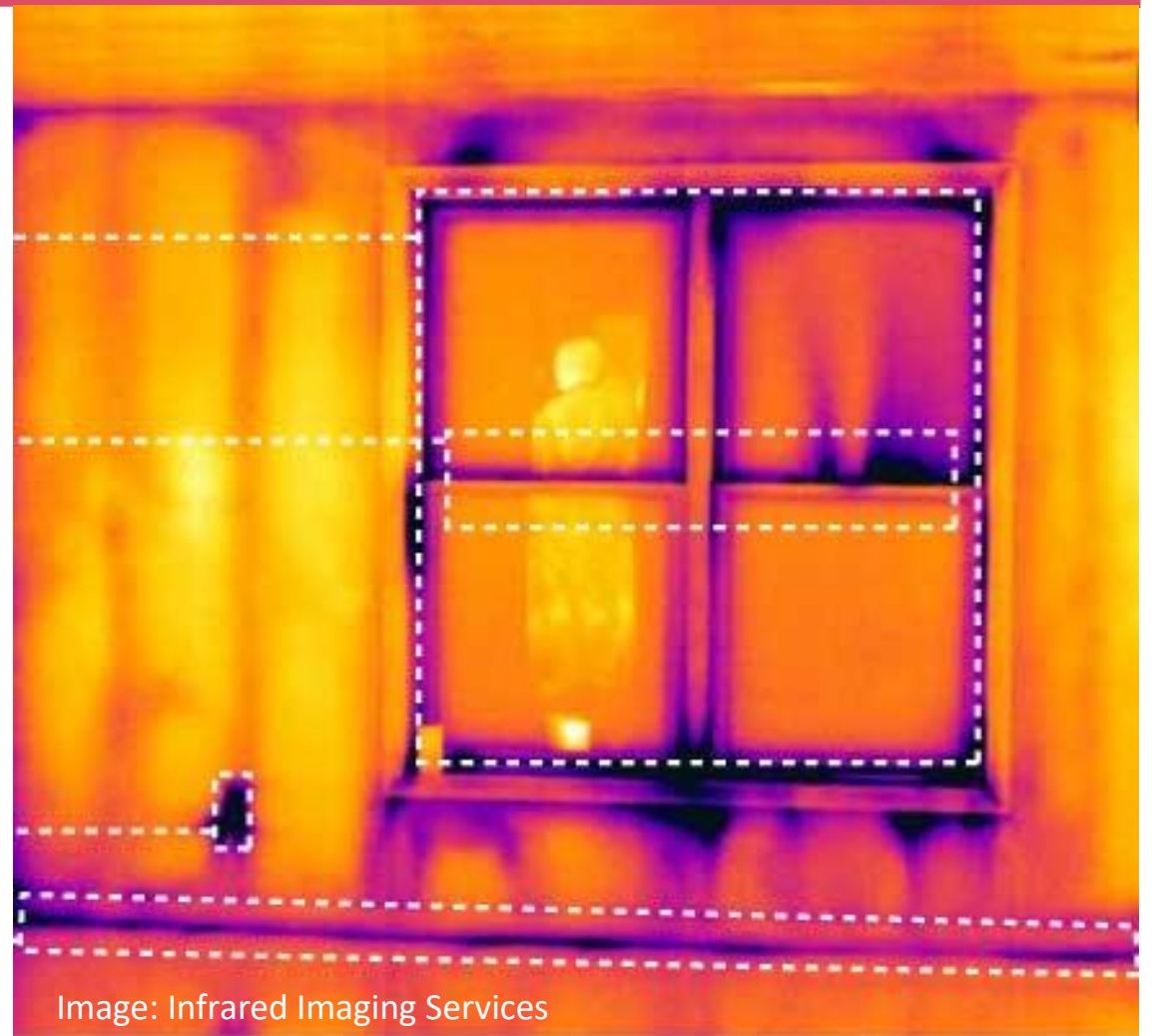


Image: Infrared Imaging Services

Experts advise Design Teams:



Hire a quality consultant (at least at first)

Upgrade your typical specs & details

Downsize HVAC equipment to reflect reduced loads from leakage (save \$ & space)

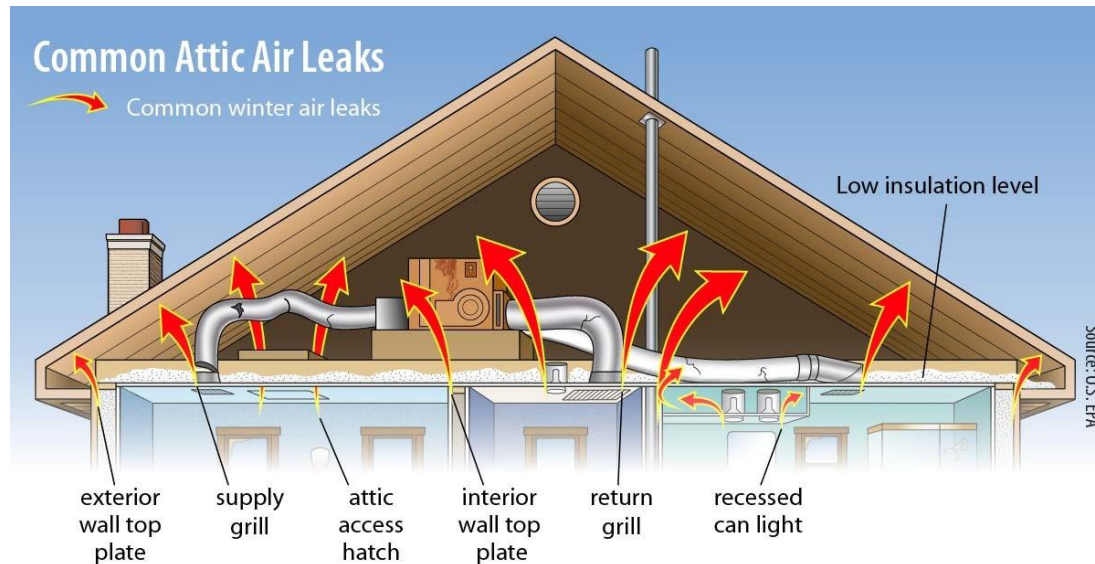
Use high-performance envelope systems, avoid lousy systems (like vented roofs)

Experts advise Contractor:

- “It’s not just words. It’s actual work. You have to put it in the schedule & budget.”
- Schedule the site shutdown
 - Maybe evening, early morning, weekend
- Define scope of each sub
 - Color code the details
- Watch transitions between trades
- Coordination & preparation
 - Pre-test plan, meeting, site walk



Leak Locations: The Top Ten

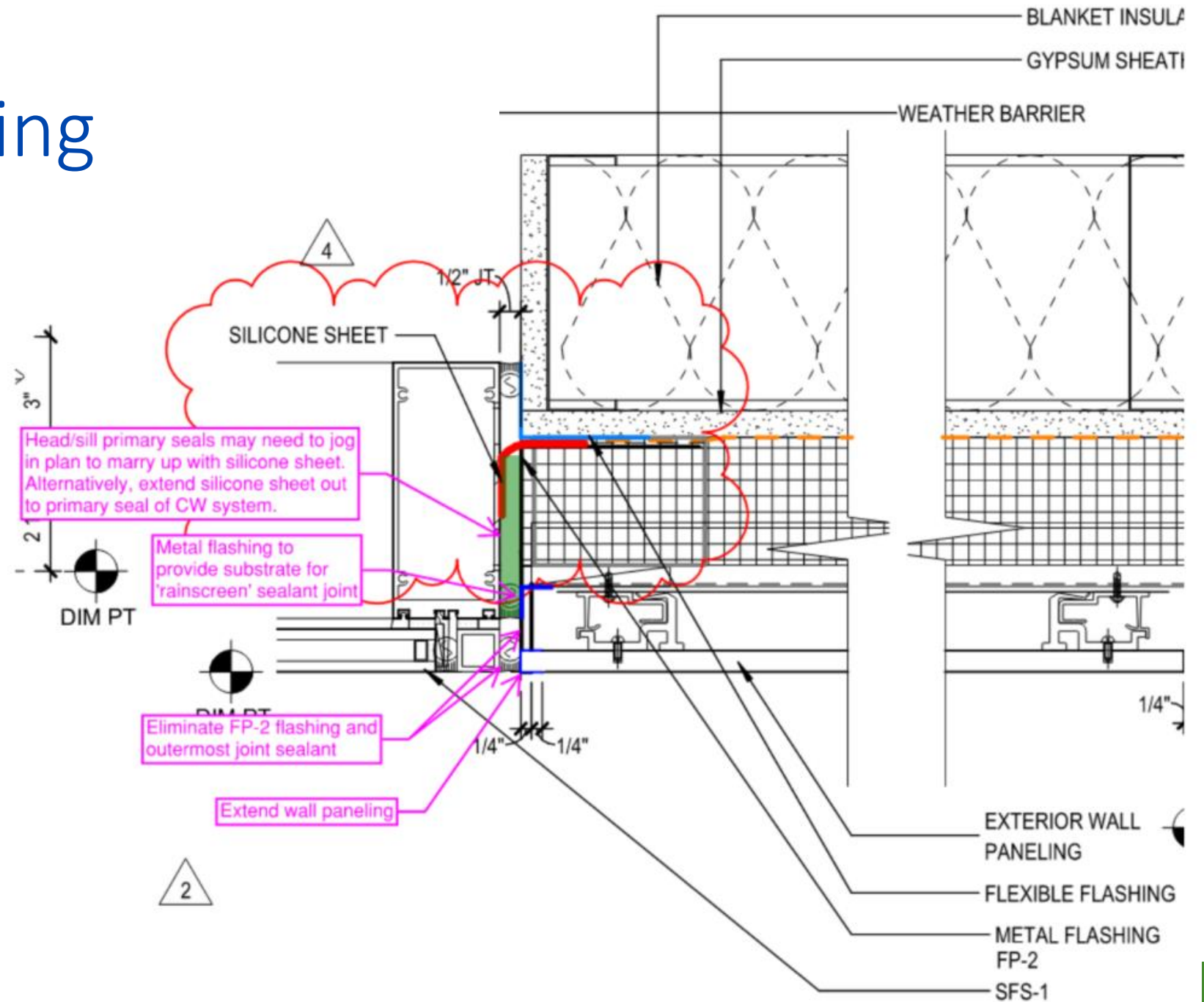


1. All “vented roof” assemblies!
2. Doors & frames – swinging, rolling, folding, everything
3. Range hoods & ducts

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

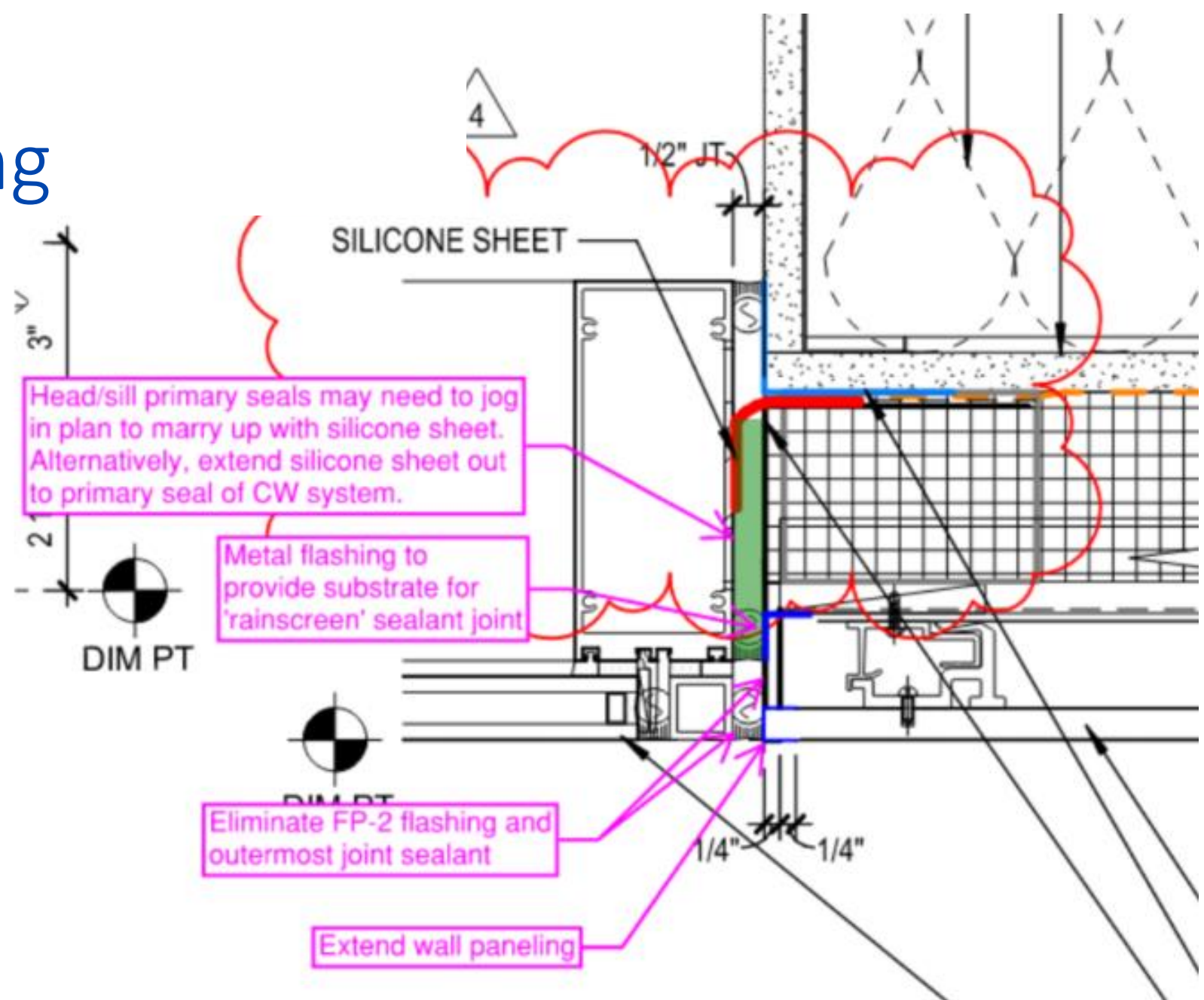
Caulking vs silicone sheeting

- Waterproofing consultants love silicone flashing!
(zoom in next slide)



Caulking vs silicone sheeting

- Waterproofing consultants love silicone flashing!



Seattle clarification:

OK to use heat pumps in “semi-heated” space

Semi-heated buildings and spaces.

- Definition: Between 3.4 and 8 BTUH installed heating, 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...

C402.1.1.2 Seattle 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.**

Envelope quality management

Continuity is everything

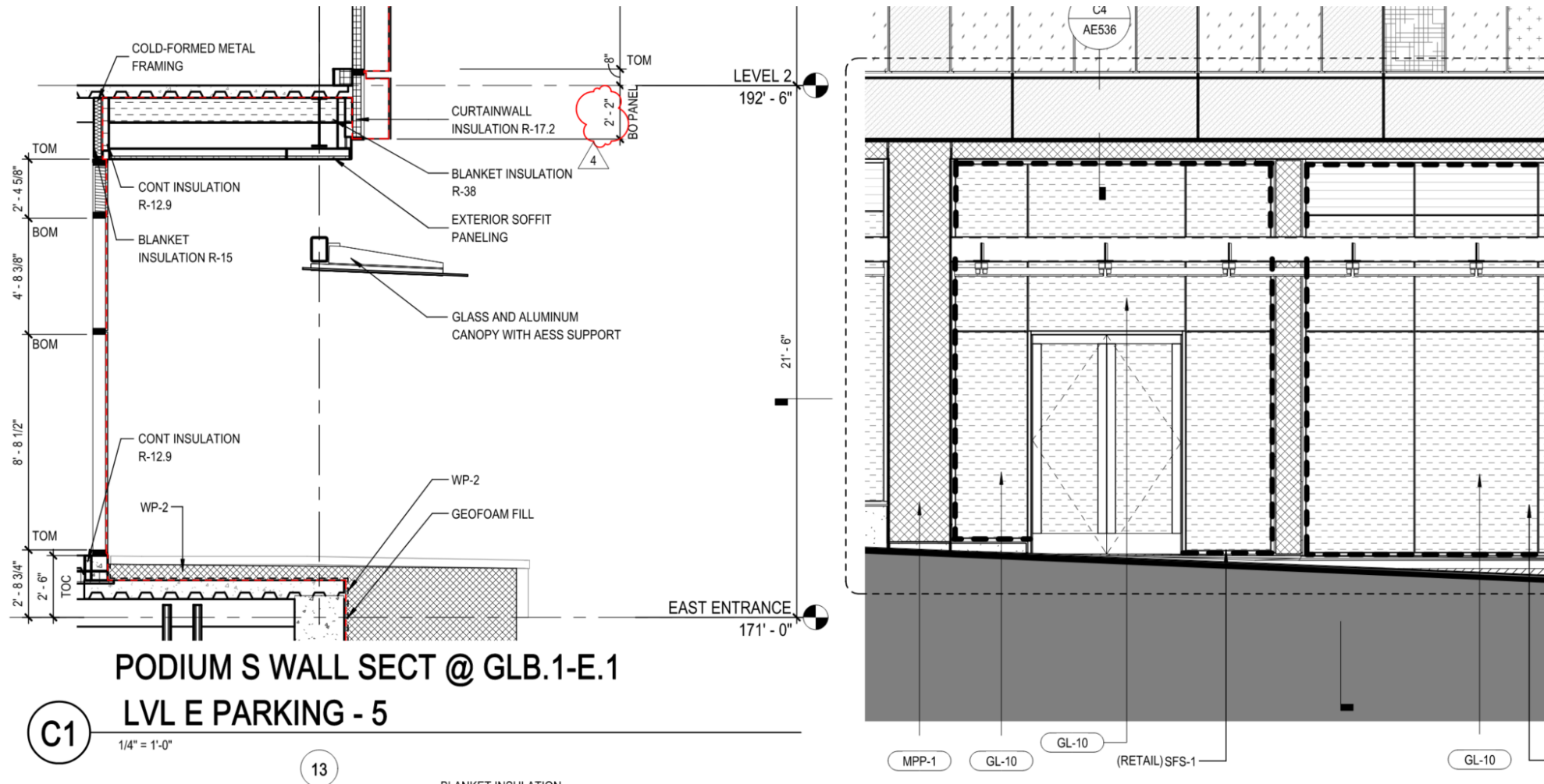
- Trace boundaries of thermal envelope & air barrier, in 3-D, around entire building
- Work out interfaces between adjoining systems, in 3-D

During construction

- Early on-site meetings
- Assign responsibilities
- Continuous QC
- Test: must pass!

Continuity of air barrier drawing

PSE drawings with air barrier are key to a great drawing set!



Renewable energy

- Seattle: ~~0.25~~ **0.75** **W/sf**, based on conditioned area of *all* floors
- WA: **0.50** **W/sf**, based on conditioned area of *all* floors
- C406.5 credit variable based on size



Also, solar readiness

- Solar-ready zone **40% of net roof**
- Seattle: now includes multifamily
- Solar zone: 4 psf extra dead load
- 2" Roof sleeve @ 2,500 sf

Size for 0.50W/sf? 0.75W?

Assume all floors same size



Stories	Roof % @ 0.50W/sf	Roof % @ 0.75W/sf
1	3.6%	5.4%
2	7.2%	10.9%
4	14.5%	21.7%
6	21.7%	32.6%
8	29.0%	43.4%
10	36.2%	54.3%
12	43.4%	65.1%
14	50.8%	76.2%
16	58.0%	87.0%
18	65.2%	97.8%
20	72.4%	108.6%

Rooftop solar installation

- **Ballasted**
 - Much heavier than attached (4 – 6#/sf)
 - Fewer roof membrane penetrations
 - Typically concrete blocks
 - Should have restraint cables for prevailing wind
 - Check with structural about seismic issues
- **Mechanically attached**
 - Lighter (1.5 – 2#/sf)
 - More roof membrane penetrations
 - Best to install standoffs with roofing
 - More flexibility with panel tilt
 - Check with structural about wind issues



Façade solar panels



- Might get cheaper, eventually
- Great for winter & morning/afternoon

C406 credit system Pick a few “above-code” options

Table C406.1 Energy Measure Credit Requirements

Required Credits for Projects	Section	Occupancy Group					
		Group R-1	Group R-2	Group B	Group E	Group M	All Other
New building energy efficiency credit requirement	C406.2	((54)) <u>59</u>	((41)) <u>45</u>	((42)) <u>46</u>	((48)) <u>53</u>	((74)) <u>61</u>	((49)) <u>54</u>
Building additions energy efficiency credit requirement	C406.2	((27)) <u>30</u>	((20)) <u>22</u>	((21)) <u>23</u>	((23)) <u>25</u>	((36)) <u>30</u>	((21)) <u>23</u>
New building load management credit requirement	C406.3	12	15	27	15	13	26

Table C406.2 – Efficiency Measure Credits

Measure Title	Applicable Section	Occupancy Group					
		Group R-1	Group R-2	Group B	Group E	Group M	All Other
24. Enhanced envelope performance ^g	C406.2.12	24	20	13	5	19	((14)) <u>16</u>
25. Base reduced air leakage ^g	C406.2.13.2	29	24	6	3	9	((11)) <u>14</u>
26. Enhanced reduced air leakage ^g	C406.2.13.3	53	44	11	5	16	((20)) <u>26</u>

20 + 24 = 44 (almost 45!)

Envelope credits

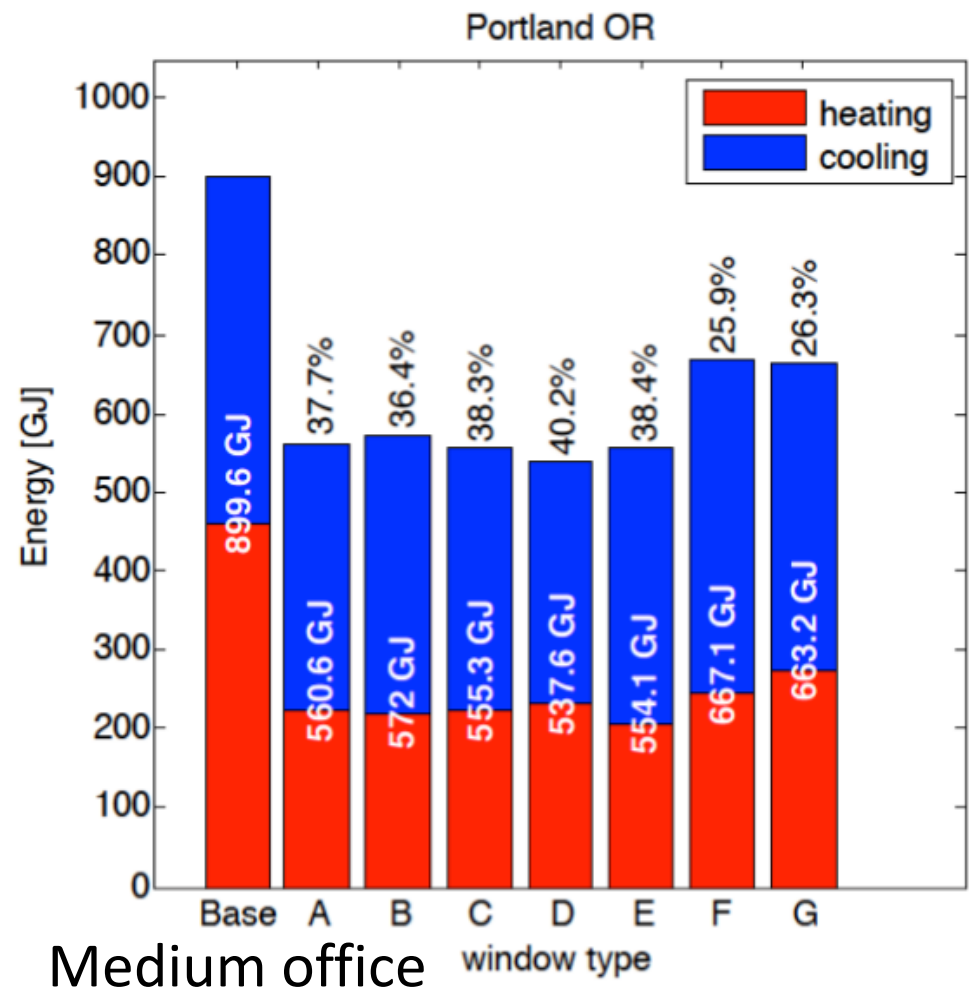
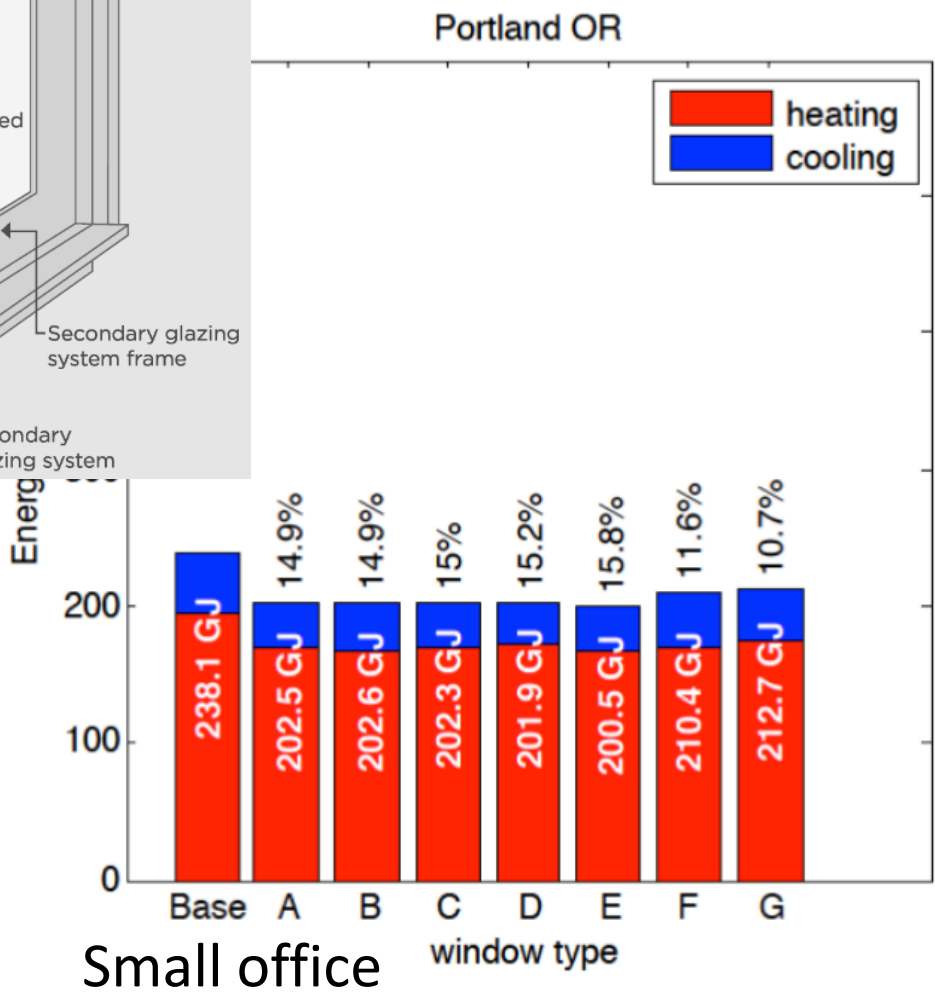
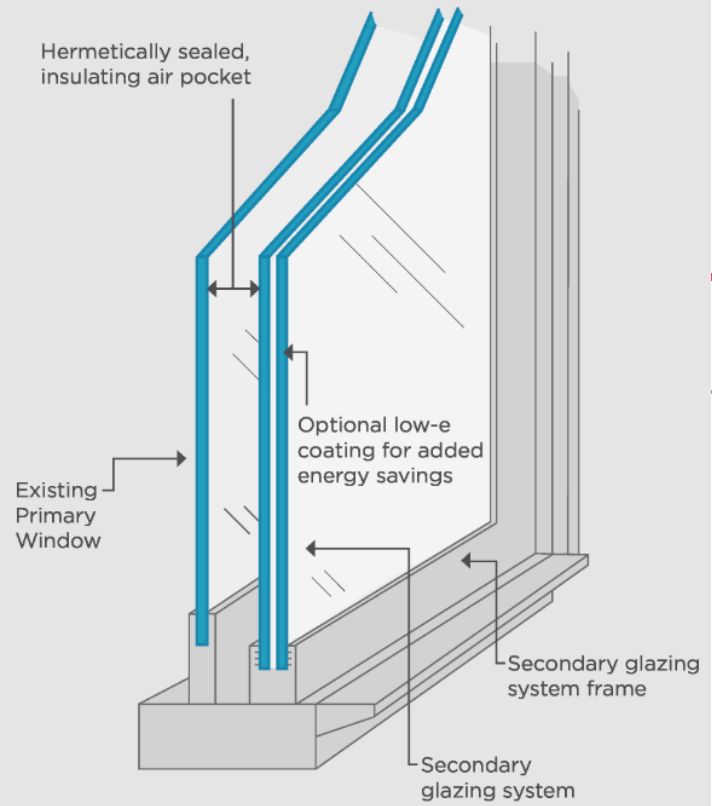
C406.2.12 Enhanced envelope performance. The Proposed Total UA of the thermal envelope of the project shall be **15 percent lower than the Allowable Total UA** determined in accordance with Section C402.1.5 and Equation 4-2.

C406.2.13.1 Base reduced air leakage. Measured air leakage shall not exceed **68 percent of the maximum leakage** allowed by Section C402.5.1.2. **($0.25 \times 0.68 = \underline{0.14 \text{ cfm}}$)**

C406.2.13.2 Enhanced reduced air leakage. Measured air leakage shall not exceed **33 percent of the maximum leakage** allowed by Section C402.5.1.2. **($0.25 \times 0.68 = \underline{0.08 \text{ cfm}} = \text{Passive House}$)**

Secondary Glazing Systems?

Lower-cost solution to upgrade facades



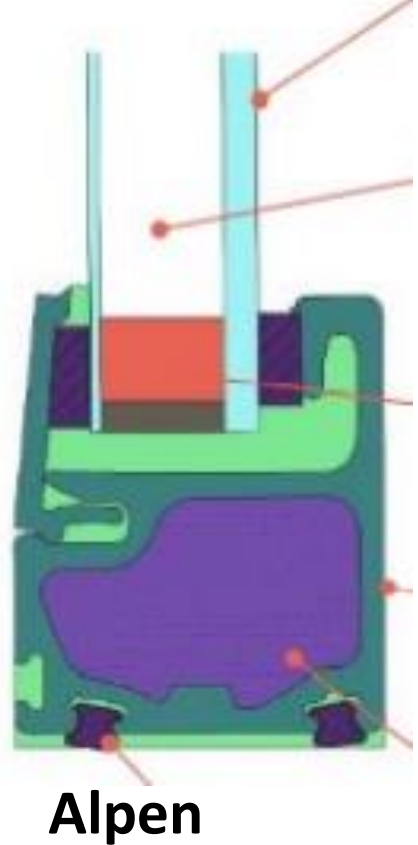
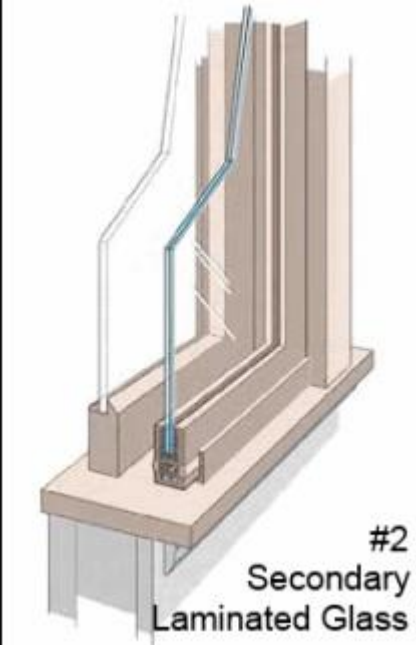
Secondary glazing systems:

Several market players

- Attachment Energy Rating Council (AERC)
- **Condensation?**

- CitiQuiet
- City Proof
- IEG

- Indow
- Thermolite
- Ecker Window



You do need a permit for reroofing...

(Seattle used to allow a blanket exemption)

Roof insulation requirements kick in.

Exceptions:

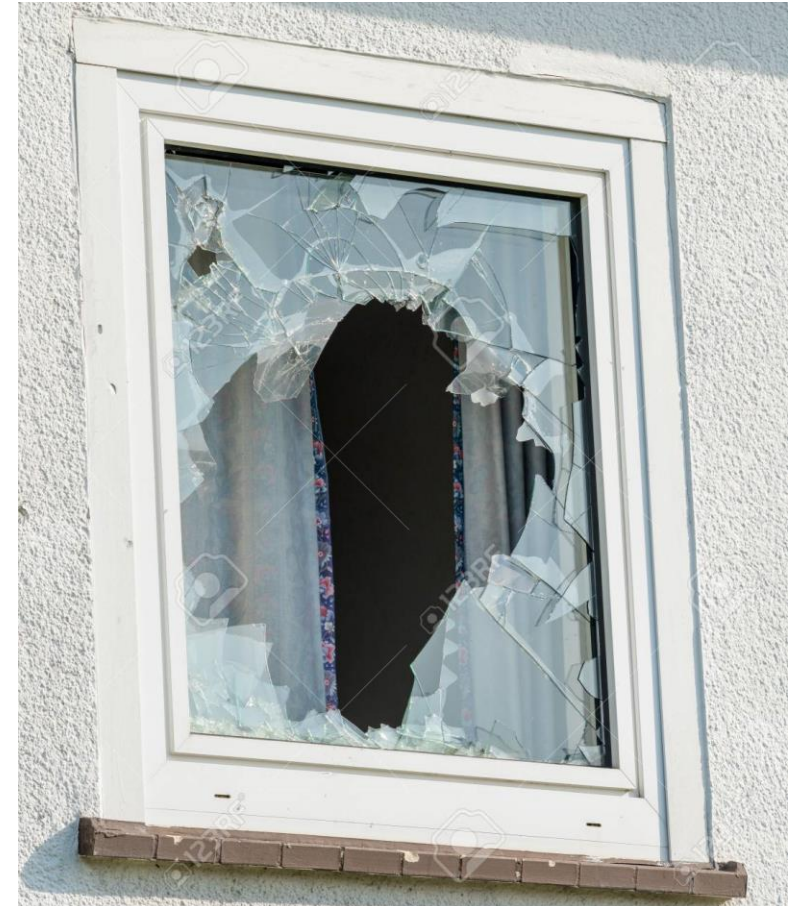
1. Single family & townhouse
2. If less than 500 sf sheathing or insulation exposed



Envelope exceptions to alteration rules

These don't have to comply with code
(...but pretty much everything else does)

- Storm windows
- Replacement glass
- Cavities exposed (just fill with insulation)
- Cavities not exposed
- Simple door replacement: vestibule not required



Air Barrier Testing – for alterations

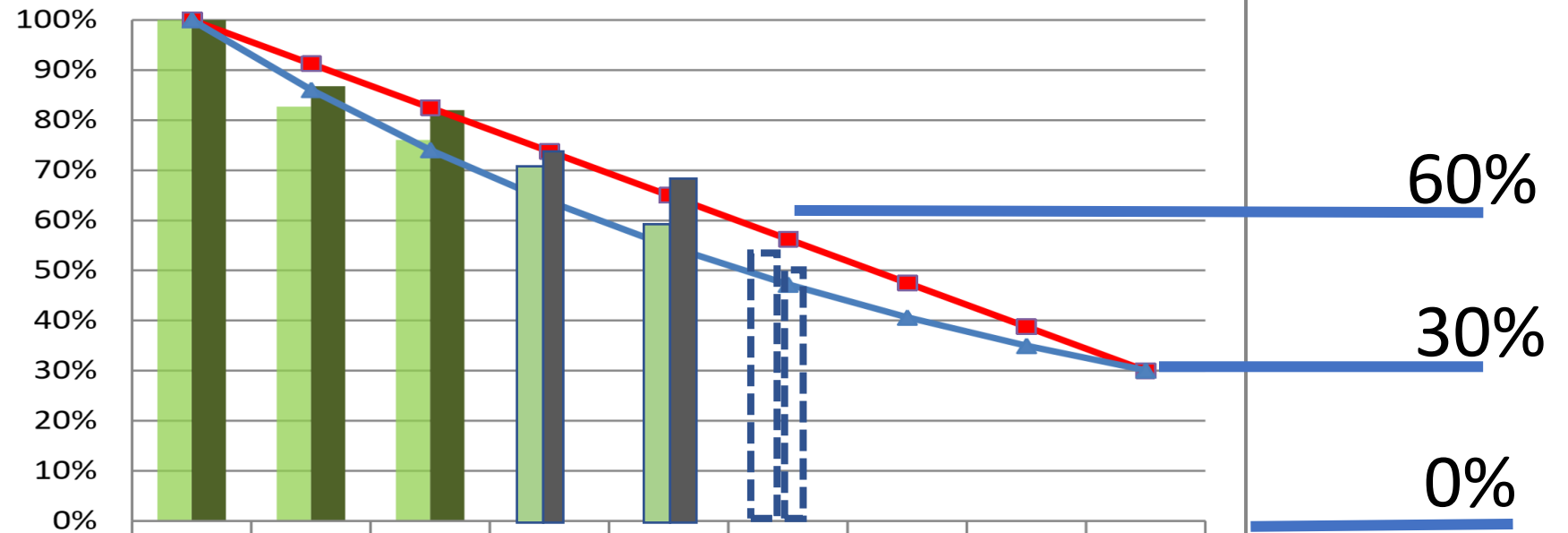
- *Not* typically required for alterations, except:
 - Change of occupancy
 - Change of space conditioning
 - Seattle: Substantial alterations



What's our ultimate target?

How do we cut energy use by *half* again?

Plus, 45% CO₂ reduction by 2030



	2006	2009	2012	2015	2018	2021	2024	2027	2030
Residential	100%	82.7%	76.1%						
Commercial	100%	86.8%	82.0%						
Target: 8.75 % savings compared to the 2006 WSEC	100%	91%	83%	74%	65%	56%	48%	39%	30%
Target: 14% savings compared to each previous code	100%	86%	74%	64%	55%	47%	41%	35%	30%



There's more to life than energy efficiency

Don't compromise human values

Health (sunlight, clean air & water)

Comfort (temperature, humidity)

Environment (pollution, carbon emissions)

Durability (long-lasting materials & equip)

Quiet (machinery, traffic)

Beauty

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Upcoming 2021 Code Update Deliveries

Webinar Topic	Delivery Date	Time
<u>HVAC</u>	May 23	10:00 – Noon
<u>Water heating</u>	May 30	10:00 – Noon
<u>Alterations, Heat Pump Upgrades</u>	June 6	10:00 – Noon
<u>Lighting, Electric & Solar</u>	June 13	10:00 - Noon

Today's slide deck and video recording can be found on

www.lightingdesignlab.com

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