



Meeting Increased Energy Demands with Aluminum Window Wall

Presented by:

Amber Mengede, Technical Manager

Mike Harrison, Architectural Representative



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Agenda

- Overview of the thermal performance of traditional window wall systems
- Misconceptions with Step Code
- Building envelope challenges
- Thermally enhanced window wall



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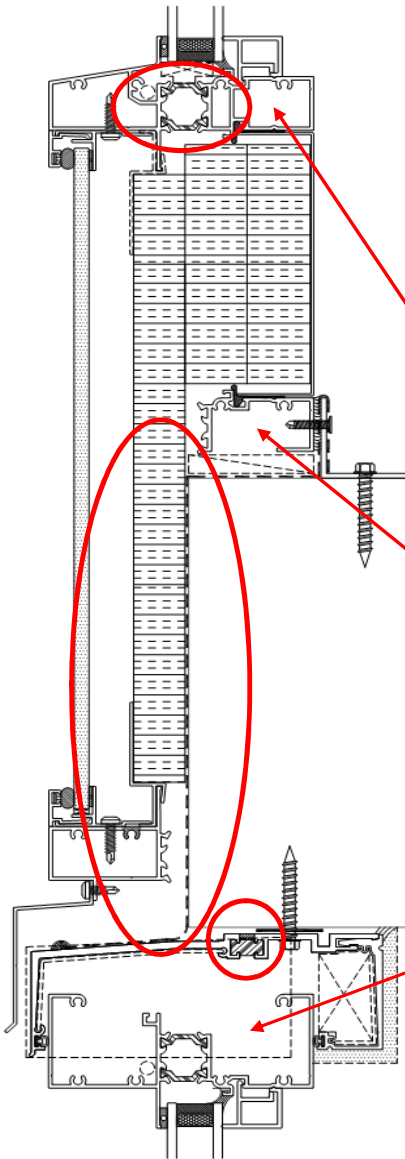
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*Thermal Performance
of Traditional Window
Wall Systems*

Traditional Window Wall System Highlights



- Minimal thermal break; +/- 21mm deep
- 1" of non-continuous mineral wool in module bypass, which also leaves the slab edge partially exposed
- Head deflection channel is partially thermally broken with a "skip and debridge" thermal break
- Little or no insulation in other frame cavities
- Operable frames and their inserts not thermally broken

Vision Glass
Areas
Double Glazed

Fixed Glazing

6mm Guardian SN68 #2 / Argon / ½" WarmEdge Spacer / 4mm CLR

U-value = 0.31* and SHGC of 0.33

Operable Glazing

Same glazing make-up as above

U-value = 0.47* and SHGC of 0.23

**Typical overall system U-value = ~0.36*

(Assumes an 80:20 ratio of fixed to operable glazing)

Opaque Wall Areas

Monolithic Spandrel Glass

6mm TEMP / Opaci-coat #2 / 3" mineral wool /
GALV backpan

U-value = 0.17

Effective R-value = R-6

**Based on a window wall module 48" in width*

*Bypass
locations*

Monolithic Spandrel Glass

6mm TEMP / Opaci-coat #2 / 1" mineral wool

U-value = 0.29

Effective R-value = ~R-3*

**Based on a window wall module 48" in width*



*BC Energy Step Code
and the Building
Envelope*

**STARLINE
WINDOWS**

Step Code:

Part 3 & 9
Buildings

With massing, simpler forms are deemed to be more energy efficient in both Part 3 & Part 9.

Size and placement of windows can influence a Part 3 building's TEDI performance or a Part 9 building's TEDI or PTL.

Step Code:

Window : Wall
Ratio (WWR)

BC Housing suggests selecting wall systems with a minimum R-10 effective and a WWR of 40% or less.

A full “skin-wrap” with a WWR >50% is possible with aluminum window wall, if a suitable system is available from the glazing trade.

Step Code:

Getting there

Performance path trade-offs are no longer permitted as they were beforehand.

To help meet the performance-based approach of Step Code, the glazing trade can offer various energy values for the energy modelers to work with.

Energy Requirements

Ask for project specific, overall weighted-average energy values based on specified glazing.

Ultimately, the glazing trade needs to be informed of the project's target energy values in order to assist.

Building Envelope Challenges

If the industry follows the 40% max WWR using thick insulated walls, there exists the potential for sequencing and tie-in issues that could lead to compromised building envelopes in the future, not to mention, possible costly schedule delays.

ACTUAL CASE: A project with windows sitting 2 3/8" proud of the slab edge and walls that are 7" proud, due to exterior insulation.

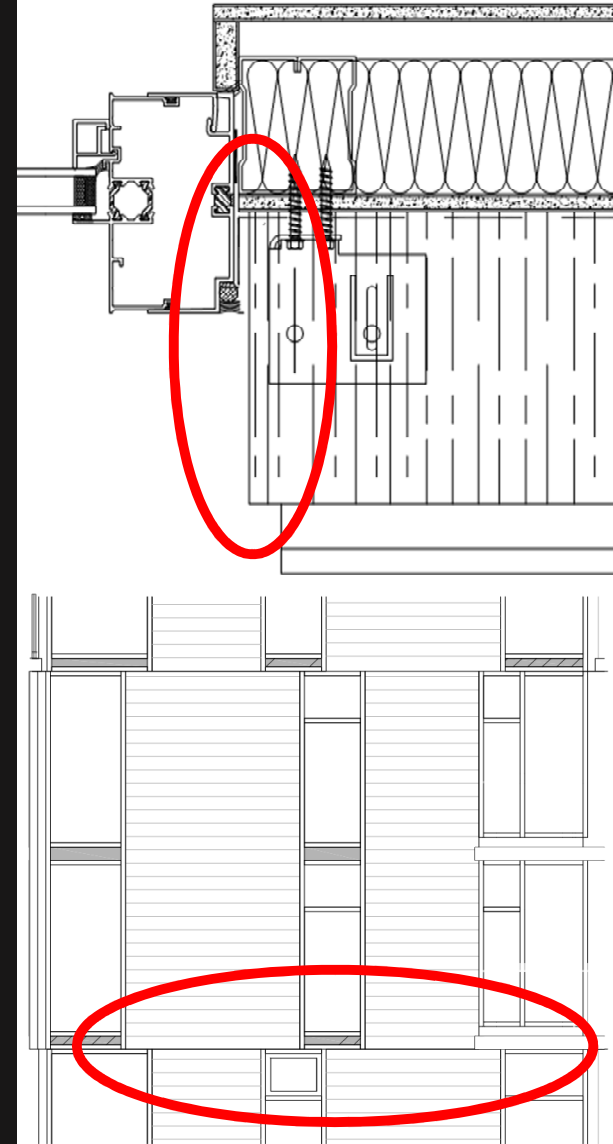
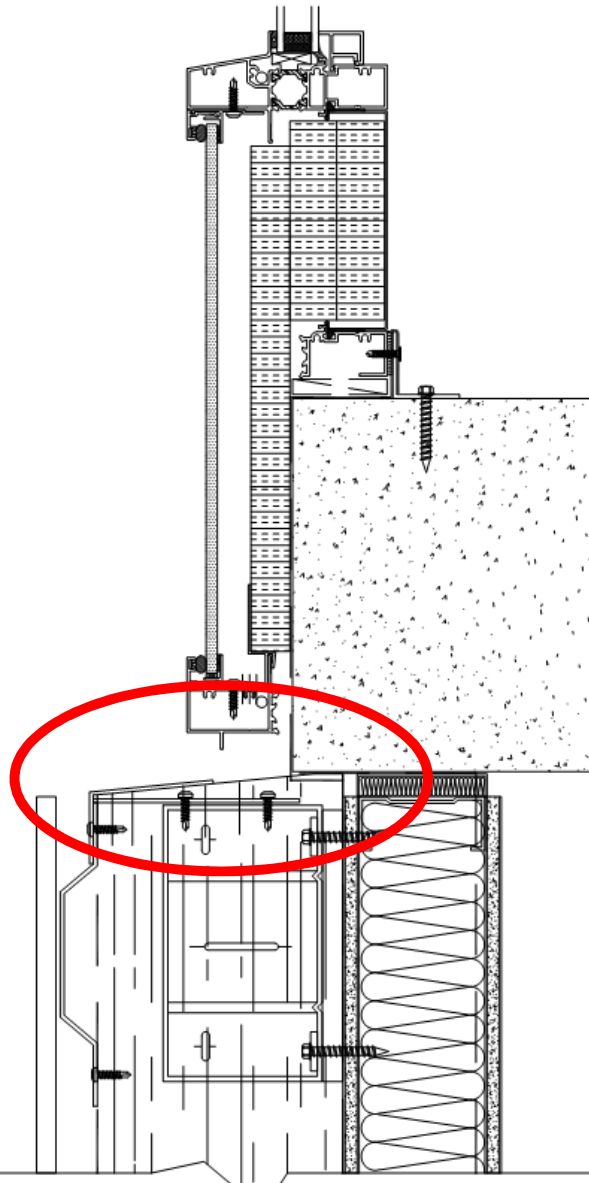
***DISCLAIMER:** not the project shown



Thick Wall Design Complexity

1. Multiple trades now responsible for the building envelope versus as few as one.
2. How do you best design the flashings and sequence the membraning and waterproofing tie-ins to ensure a sound building envelope?
3. Windows are “staggered” across the elevations, as opposed to being contiguous, making this even more difficult to detail.*
4. Despite several round table discussions with the building envelope consultants & the architects, the general contractor & their client, along with the cladding trade & window manufacturer, a satisfactory flashing detail has not yet been finalized!

**The details shown do not represent the true complexity of the scenario.*



Pros & Cons of a Skin Wrap with Thermally Enhanced Window Wall

Skin Wrap Pros

- One trade on the building envelope
- Scheduling & sequencing easier
- Simplicity of detailing & tie-ins
- Designing for interstory drift easier with one system
- Potential for >40% window:wall ratio
- Unitized system built in factory-controlled environment

Skin Wrap Cons

- Potentially lower energy performance in opaque wall areas
- May be limited aesthetically in terms of other product options for opaque walls

Pros & Cons of a Punched Window Design

Punched Opening Pros

- Potentially better energy values for the opaque areas around the windows
- Design flexibility of cladding options

Punched Opening Cons

- Multiple trades responsible for the building envelope
- Scheduling & sequencing can be problematic and cause delays
- Complexity of detailing & tie-ins
- Increased potential for thermal bridging with steel studs and large flashings

Building Envelope Opportunities

Can I achieve an R-10 effective wall without using a thick wall?

Can I meet Step Code now with aluminum window wall?

Can I design to greater than a 50% WWR?



Thermally Enhanced Aluminum Window Wall

**STARLINE
WINDOWS**

What was the process in designing this new thermal window wall?

Thermal performance

Structural requirements

Manufacturing feasibility

Shipping & installation criteria

Cost / competitively priced

Thermally Enhanced Window Wall

What should
you look for...

Larger, continuous thermal breaks in all components including the head deflection channel, seismic jambs, vent inserts and operable vents

More insulation in the various frame cavities than seen before in traditional window wall systems

Insulation applied “continuously” on the face of the slab edge

...and what
can you
expect?

Overall thermal performance is improved up to 100% compared to traditional window wall systems.

U-fen as low as 0.165*
(Fixed / non-operable glazing)

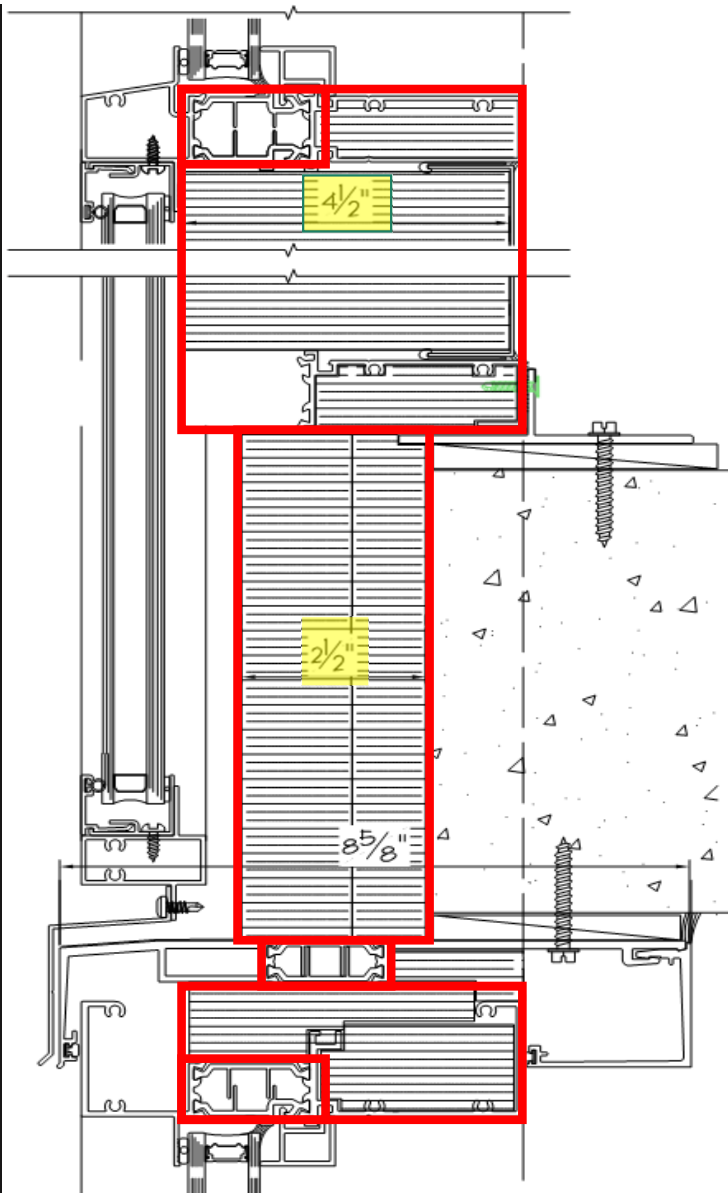
****Triple glazed with soft coat low-E on surface #2 & #4 with hard coat low-E on surface #6.***

Multi- chamber Dual-strut Polyamide Thermal Break

Using a larger thermal break improves energy performance, however it can allow for increased convection and decrease thermal resistance

By adding fins to this larger thermal break, convection within the cavity is reduced, resulting in overall improved thermal performance

Polyamide is superior to PVC for thermal breaks as polyamide is structural in nature with its glass reinforcing fibres

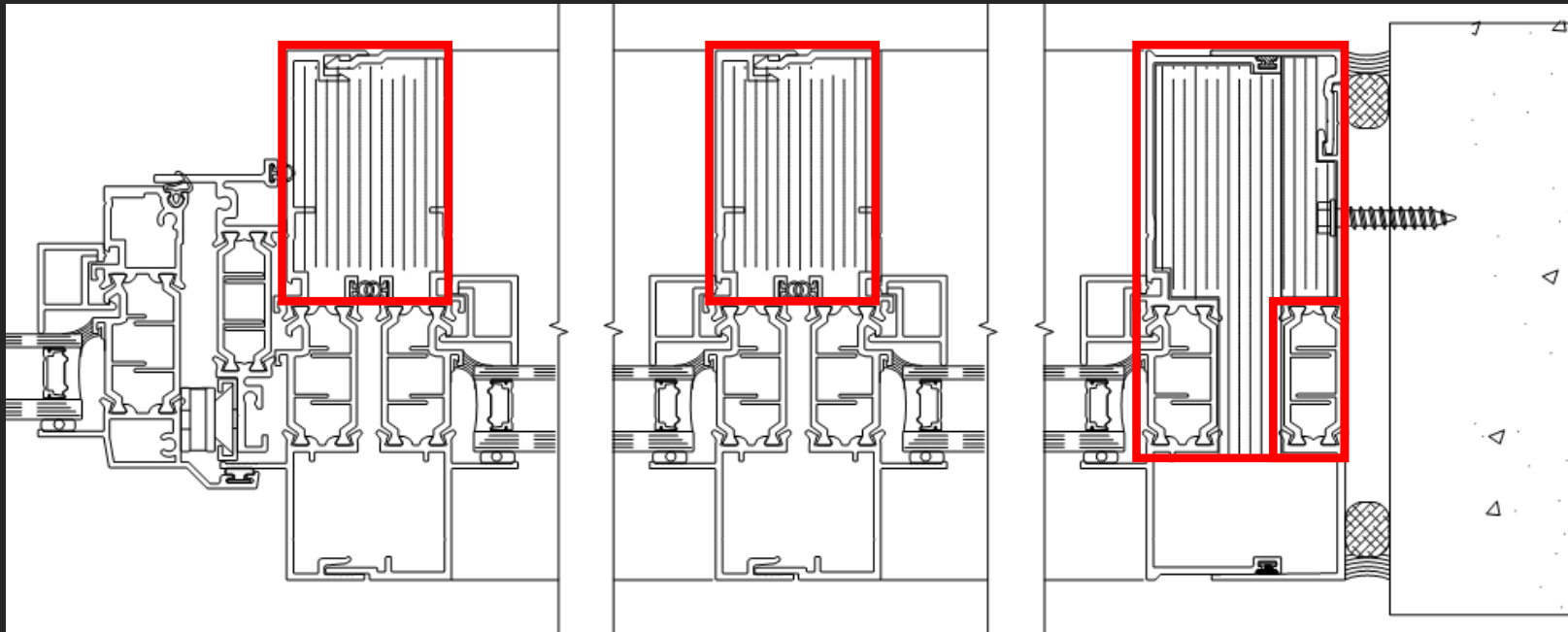


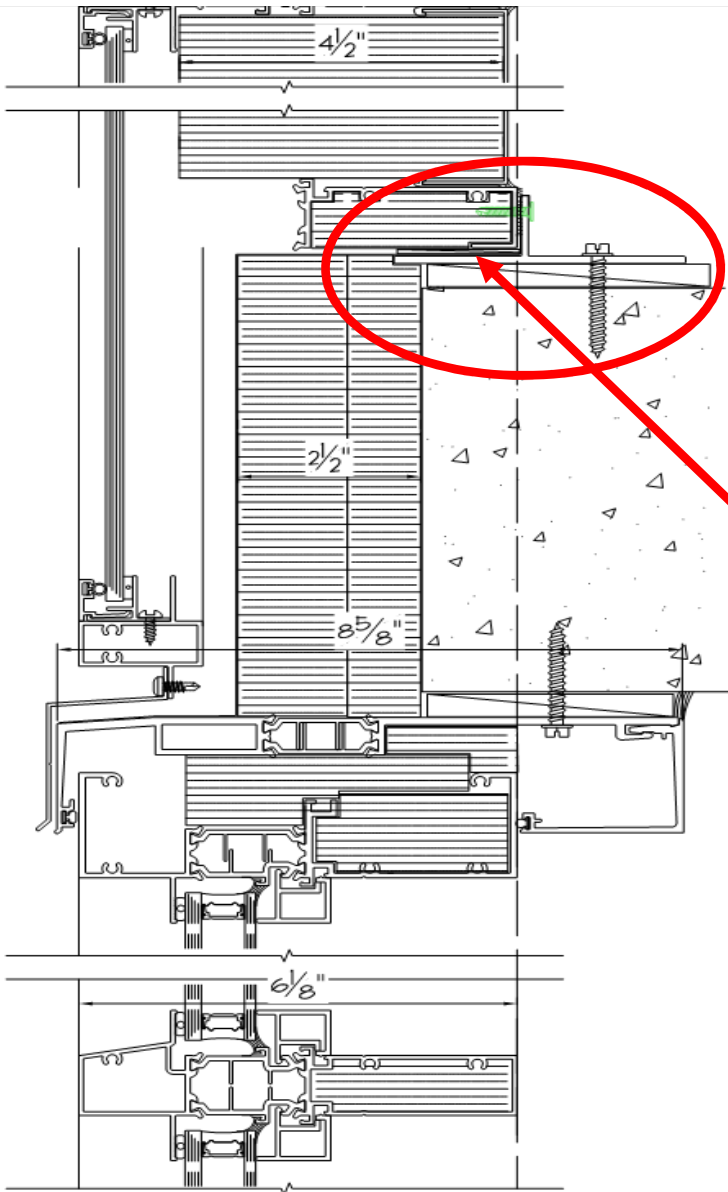
Key insulating features...

- Larger (41mm) multi-chamber, dual-strut polyamide thermal break in all window profiles
- 2 1/2" of continuous mineral wool at face of slab edge
- Head Deflection Channel is now completely thermally broken with a similar multi-chamber, dual-strut polyamide thermal break vs "skip and debridge"
- Increased amount of insulation in various frame cavities, including 4 1/2" of R-19 mineral wool in the spandrel backpan
- Intermittent shims between the perimeter frames & the structure provide an additional thermal break and addresses concrete tolerances at the same time

Additional Insulating Features

Mineral wool insulation in the cavities of all couplers, seismic jamps and the aluminum corner posts (not shown), as well as the larger, 41 mm thermal break in the seismic compensation jamb channel.





Slab Edge Positioning

- The new system is 6 1/8" deep overall, however, the nominal support on the slab does not need to be any greater than traditional systems.
- Designed for 1 7/8" nominal support using a T-angle allowing for the 2 1/2" of mineral wool blanketing the slab edge continuously.
- No impact on membrane detailing
- Effective R-value at slab edge increases to ~R-9 as a result

Why can the system sit so far outside the structure?

Structural polyamide thermal break with glass reinforced fibres

The hems of the aluminum profiles are knurled and then the thermal break is crimped in place

Rigorous QA/QC process includes slippage failure shear tests of all profiles, ensuring structural integrity

Structurally simulated and modelled in Ansys

Experience with installing cantilevered 6" deep window wall systems



*Energy Values for
Thermally Enhanced
Window Wall*

2D Energy
Values
Double Glazed

Fenestration Values

(incl. frame, mullions, sash w/ vision glass)

Soft Coat Low-e #2 / CLEAR w/Argon, WarmEdge Spacer

Ufen = 0.30* and SHGC of 0.32

Soft Coat Low-e #2 / Hard Coat #4, Argon, WarmEdge

Ufen = 0.26 and SHGC of 0.32

**Traditional system has a Ufen of 0.36 by comparison
(Assumes an 80:20 ratio of fixed to operable glazing)*

2D Energy
Values

Triple glazed

Fenestration Values

(incl. frame, mullions, sash w/ vision glass)

Single Low-e (Soft coat)

Soft Coat #2 / CLEAR / CLEAR w/Argon, WarmEdge Spacer

U_{fen} = 0.25 and SHGC of 0.30

Double Low-e (Soft & Hard coat)

Soft Coat #2 / CLEAR / Hard Coat #6 w/Argon, WarmEdge

U_{fen} = 0.22 and SHGC of 0.29

(Assumes an 80:20 ratio of fixed to operable glazing)

2D Energy
Values

Triple glazed

Fenestration Values

(incl. frame, mullions, sash w/ vision glass)

Double Soft Coat

Soft Coat Low-e #2 and #4 / CLEAR Argon, WarmEdge
Spacer

= Ufen of 0.21 and SHGC of 0.26

Double Soft Coat & single Hard Coat

Soft Coat Low-e #2 and #4 / Hard Coat #6, Argon,
WarmEdge

= Ufen of 0.18 and SHGC of 0.25

(Assumes an 80:20 ratio of fixed to operable glazing)

2D Energy Values

Bypass

Monolithic spandrel glass: ~R-8*

Shadowbox spandrel glass: ~R-9*

**Traditional system averages approx. R-3 at the slab edge.*

2D Energy Values

Opaque Walls

Monolithic Spandrel Glass: **~R-11***

Shadowbox Spandrel Glass: **~R-12***

Opaque energy values can be further improved using insulating blanket in lieu of mineral wool resulting in **~R-18.2 effective.**

**Traditional system averages R-6 at opaque walls*

(Based on a test size of 47" x 59")

How were
these energy
values
determined?

2D modelling by in house
certified NFRC Specialist for
spandrel and vision areas using
NFRC methodology

City of Vancouver's Energy STEP
Code modelling guidelines were
followed

Besides 2D modelling, 3D modelling was performed by a third party

City of Vancouver's Energy STEP Code modelling guidelines has seven different possible methods to be used for modelling spandrel. Both 2D & 3D are one of the allowable methodologies

Would make it simpler to streamline the requirements (similar concept to NFRC) so there can be apple-to-apple comparisons. Having seven different methods leads to inconsistent results between manufacturers.

NFRC is currently working on implementing a standard for modelling spandrel

3D Thermal Modelling Results

Table 3.1.3: Thermal Transmittance for Starline 9600 Window Wall System: Full Height Spandrel (Scenarios 3 and 4)

Scenario		Inboard Insulation Nominal R-Value ft ² hr °F/Btu (m ² °K/W)	U-Value Btu/h ft ² °F (W/m ² °K)	Effective R-Value ft ² hr °F/Btu (m ² °K/W)
3	Baseline	R-0 (0.00)	0.079 (0.45)	R-12.6 (2.23)
4	1" Inboard Insulation	R-4.2 (0.74)	0.067 (0.38)	R-14.9 (2.62)
	1.5" Inboard Insulation	R-6.3 (1.11)	0.063 (0.36)	R-15.9 (2.80)
	2" Inboard Insulation	R-8.4 (1.48)	0.059 (0.34)	R-16.8 (2.96)
	2" Inboard Rigid Insulation	R-10 (1.76)	0.057 (0.33)	R-17.4 (3.07)
	3" Inboard Insulation	R-12.6 (2.22)	0.054 (0.31)	R-18.5 (3.27)

Source: Morrison Hershfield Thermal Analysis Report (#180508701); September 9, 2019.

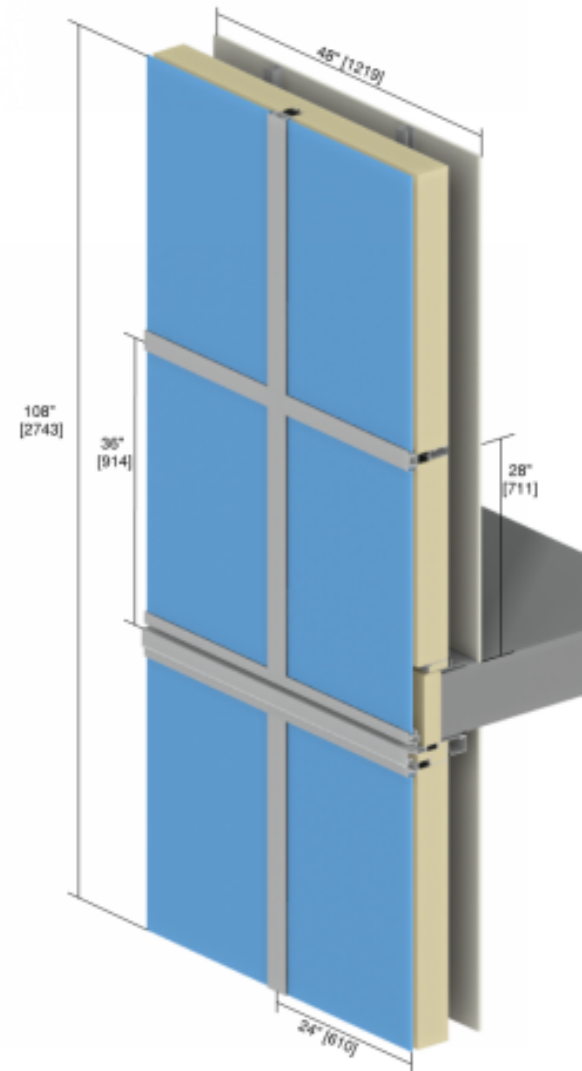
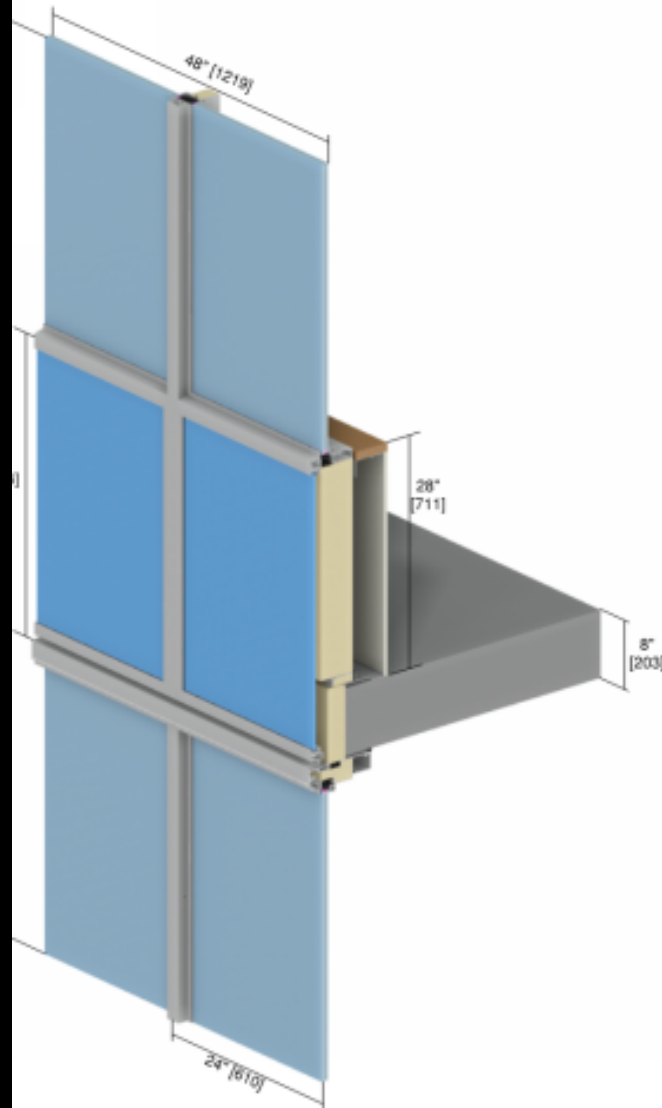
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Modelling Geometry for Thermal Wall

Upstand spandrel section of 28" plus 8" bypass

And

Full height, floor to floor spandrel with bypass

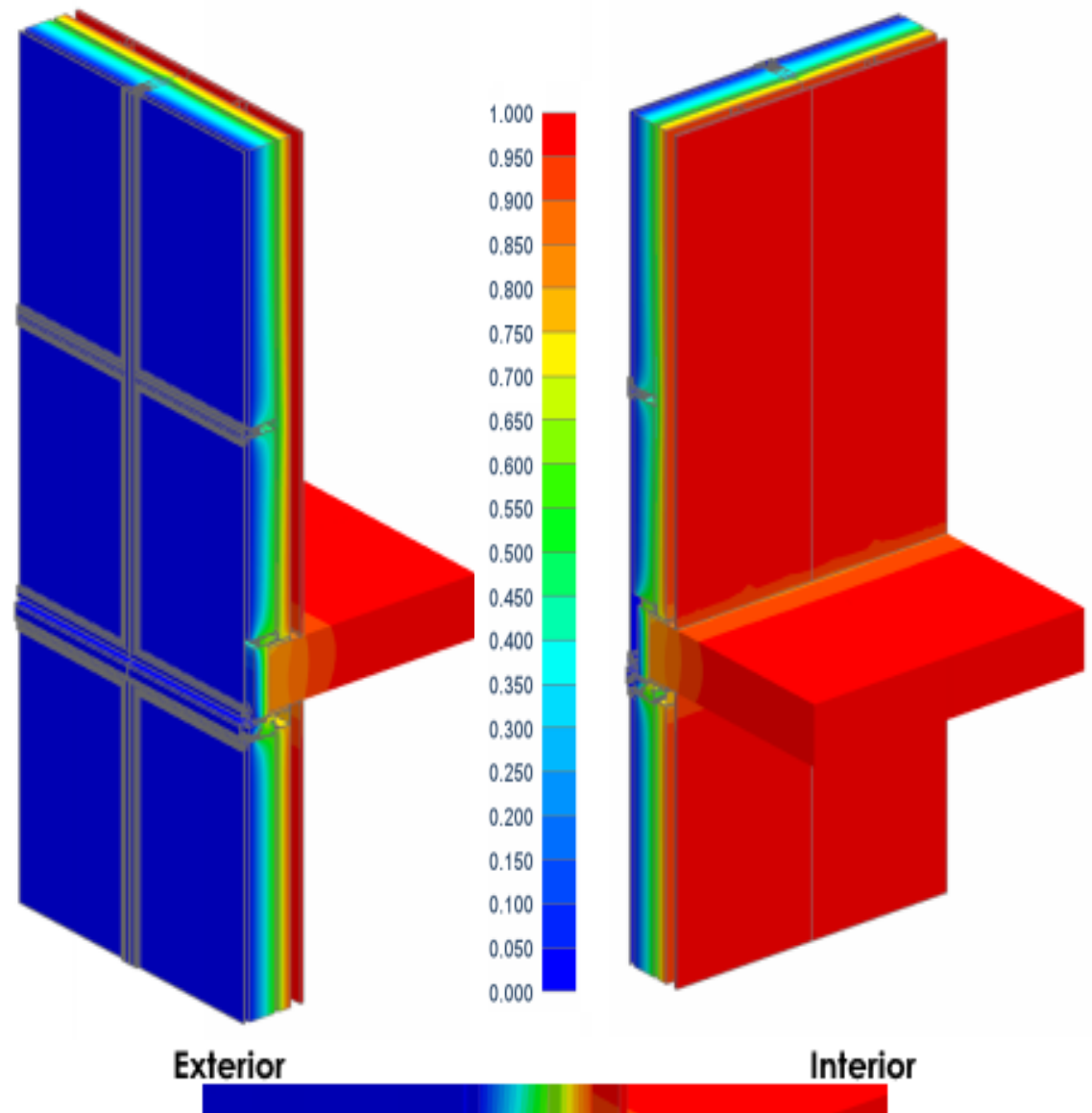


Thermal Wall Overall Temperature Profile

Full height, floor to floor spandrel with 2" of inboard insulation.

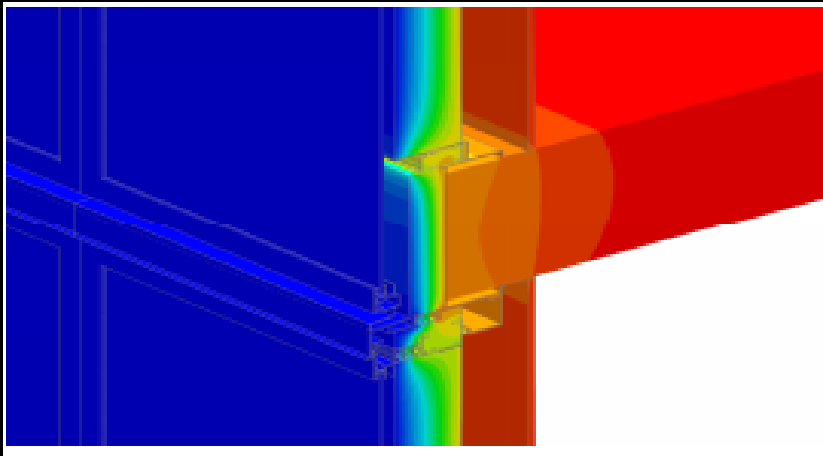
(Presented as a temperature index between 0 and 1)

Source: Morrison Hershfield Thermal Analysis Report #180508701 dated September 9, 2019.



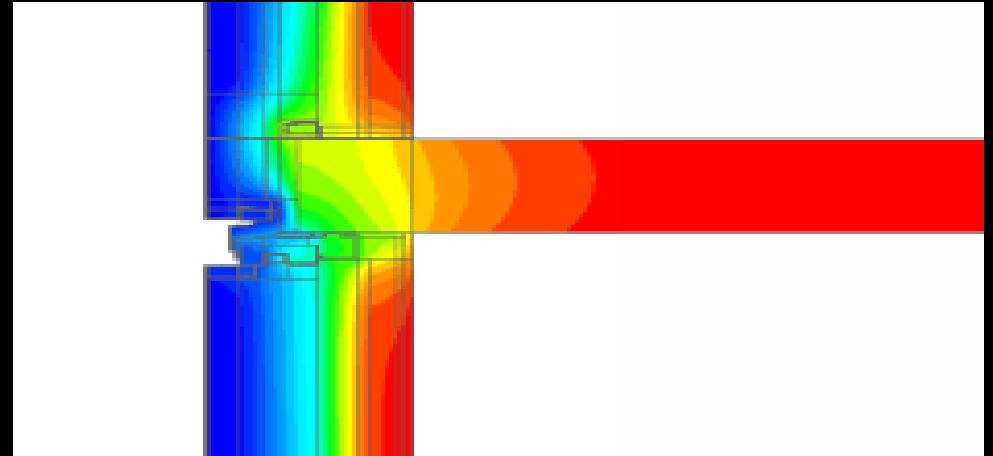
Slab Edge Temperature Profile Comparison

New (9600 Series) Thermal Wall



2 ½" continuous mineral wool at the slab edge;
no insulation in stud wall behind the spandrel

Traditional (9003 Series) Window Wall



1" continuous mineral wool at the slab edge; 3" medium
density spray foam in stud wall behind the spandrel

3D vs 2D for Thermal Modelling

3D modelling offers a high level of accuracy as it directly models the geometry and heat flow as a complete system of connected components

2D modelling has been traditionally what window manufacturers have been using for years.

The biggest difference between 3D & 2D is the surface temperature and evaluating the condensation risk

Surface temperatures for 2D are averages at best due to lateral heat transfer from the aluminum framing and metal back pans in 3 dimensions

Although ideal to use the most accurate 3D method for project-specific spandrel sizes, it is not feasible due to the cost, time and limited availability of personnel qualified in 3D modelling

Energy Value Results

3D vs 2D

Our in-house certified NFRC simulator 2D modelled the same module sizes as were used in Morrison Hershfield's thermal analysis report, where 3D modelling was used.

The 3D modelling report verified our in-house 2D modelled results, where ours were deemed conservative by comparison.

Accounting for
Thermal
Bridging...

as specified by
the BC Energy
Step Code

Accounting for thermal bridging of installation components has typically been done by the BEC's to date

It typically falls within their scope of work versus the manufacturers' and they have the capability to do so

Thermal Bridging of Installation Components

All fasteners are inboard of the thermal breaks

Sill flashings are attached outboard of the thermal break to an exterior, downward leg

Use of pan flashings is discouraged wherever possible to further mitigate thermal transfer

Summary

- Traditional aluminum window wall systems are thermally challenged.
- Misconceptions with the Step Code is suggesting window-wall-ratios need to be much lower than we're used to seeing in BC.
- Building envelope detailing and sequencing may prove difficult to resolve with multiple trades.



The future...

With a thermally enhanced aluminum window wall system, building envelope designs may not have to change as drastically as first thought to meet increased energy demands and the BC Energy Step Code.





*Thank you!...and please contact us
for technical and design inquiries.*

architectural@starlinewindows.com

technical@starlinewindows.com

604-882-5100

