

IMPACT OF FENESTRATION ON THE OVERALL THERMAL PERFORMANCE OF THE BUILDING ENVELOPE

Mario D. Gonçalves, Eng.
Principal



CONTEXT



EFFECTIVE THERMAL RESISTANCE

- *Effective thermal resistance (R-value) means the inverse of overall thermal transmittance (U-value).*

$$R_{\text{eff}} = 1/U$$

*Overall thermal transmittance (U-value) is a measure of the rate at which heat is transferred through a building **assembly** subject to a temperature difference ($U=1/R$).*

PARALLEL PATH HEAT FLOW METHOD

The overall thermal transmittance (U_{overall}) is the area weighted average of the thermal transmittance of the components of an overall assembly.

The equation for thermal transmittance of an assembly is as follows:

$$U_o = (A_1/R_1 + A_2/R_2 + A_3/R_3 + \dots)/A_o$$

Where:

A_1, A_2, A_3, \dots = the cross-sectional area of the different elements, such as opaque walls, windows and doors.

R_1, R_2, R_3, \dots = the cross-sectional R -value of the different elements.

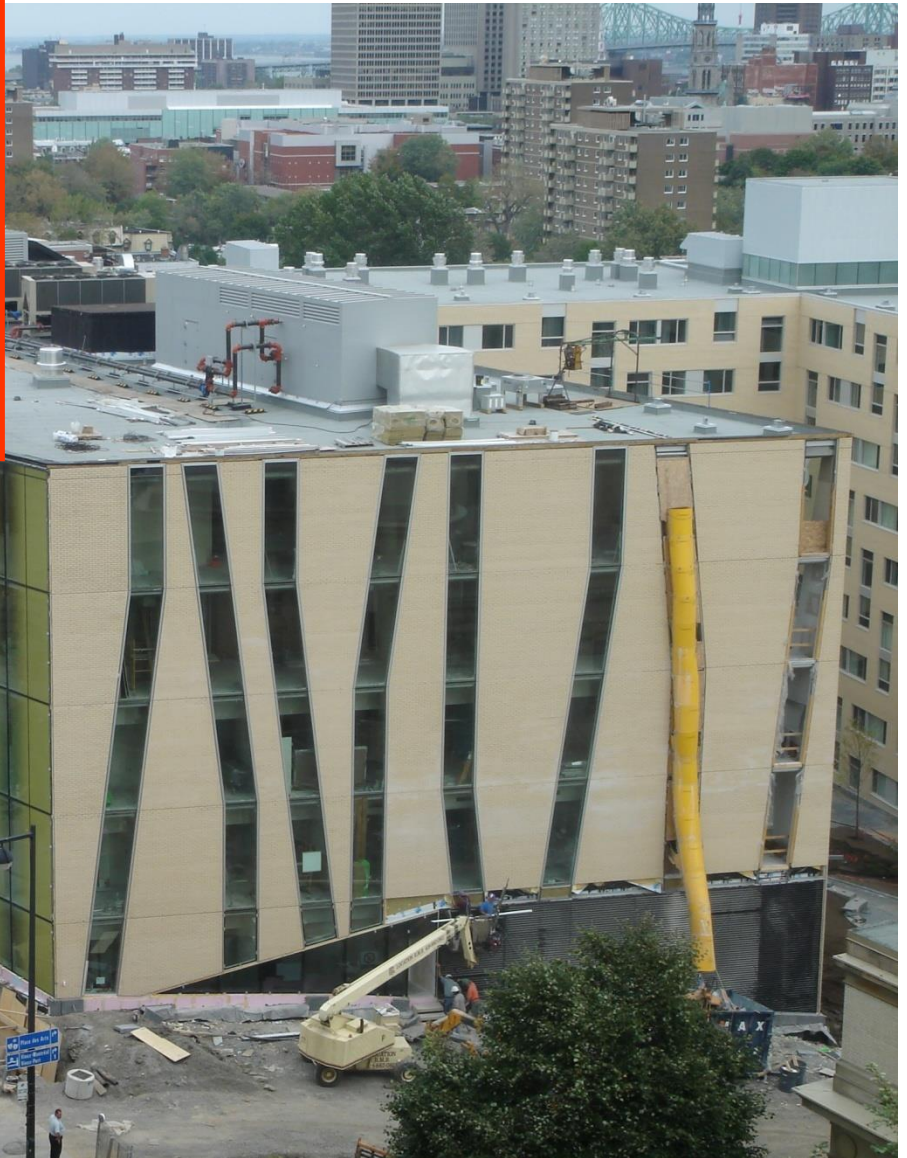
A_o = the gross area of the element or overall assembly.

The procedure for calculating a total facade heat transfer is to add each of the component heat transfers :

$$U_{\text{overall}} = \sum (U_c A_{pc}) / \sum A_{pc}$$





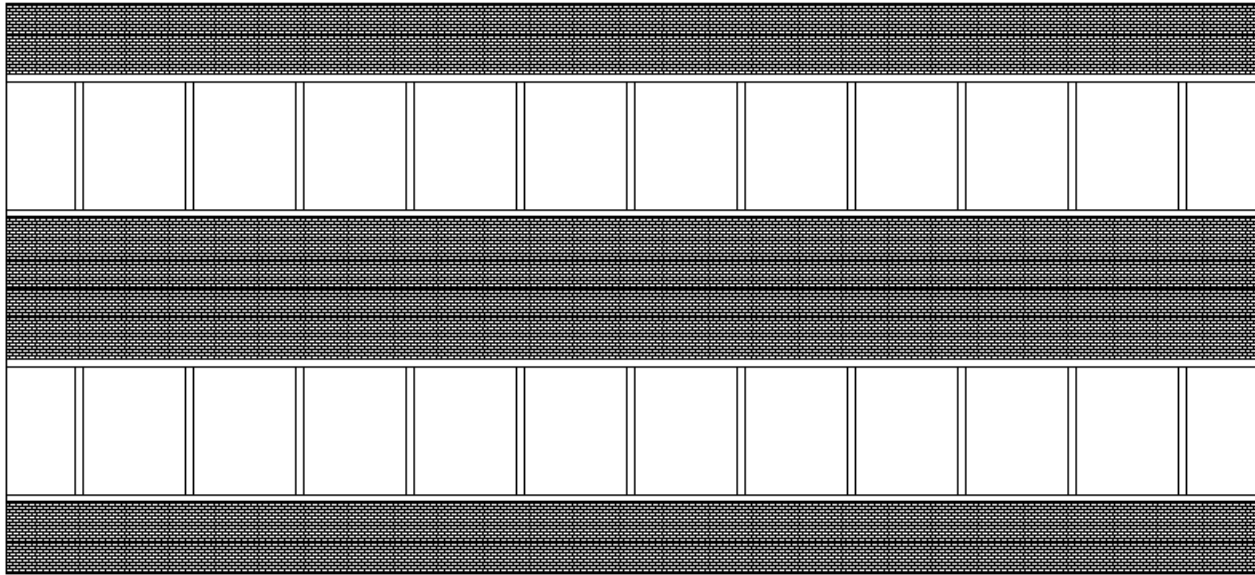






02/03/2012

Window versus wall ratio



50% fenestration

R2

50% wall

R20

Average thermal resistance

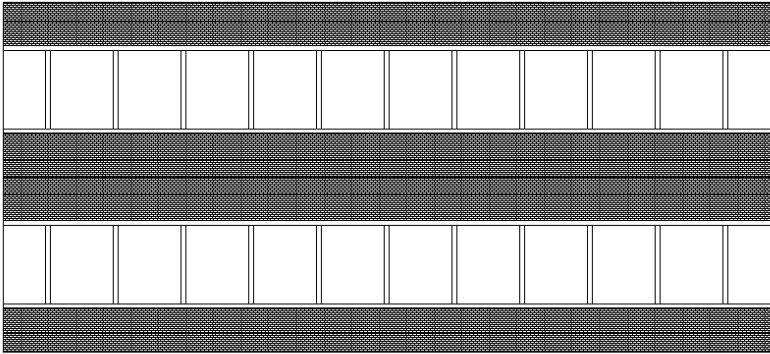
$(R2+R20)/2$ **does not = R11**

Effective Thermal resistance

$[(1/R2 * 0.5) + (1/R20 * 0.5)] / 1 = \mathbf{R3.6}$

Example for two identical buildings

A



50% fenestration (R2)

50% wall (R20)

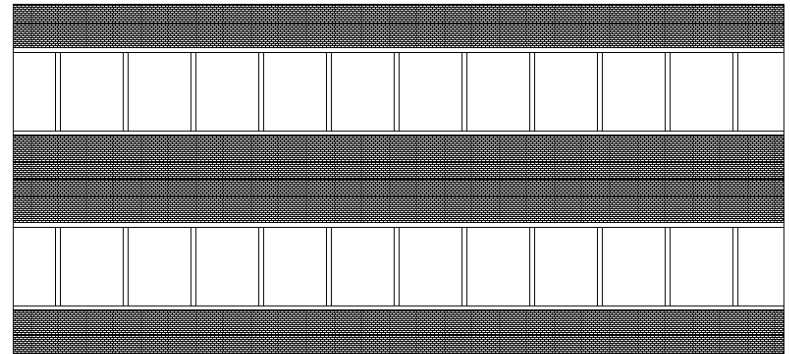
R3.6

Window: R2

Wall: R40

R_{eff}: R3.8

B



50% fenestration (R2)

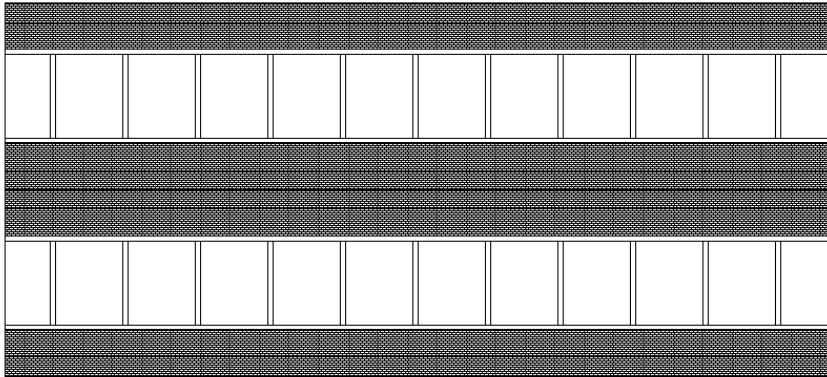
50% wall (R20)

R3.6

Window: R4

Wall: R20

R_{eff}: R6.7



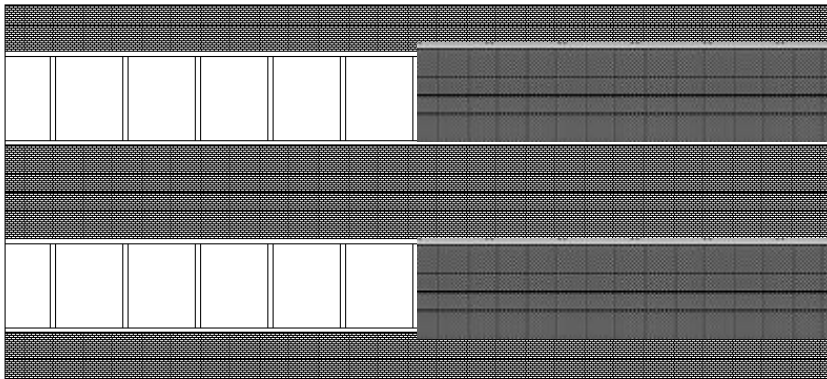
50% Fenestration

50% Wall

Window R2, Wall R20; **R3.6**

Window R2, Wall R40; **R3.8**

Window R4, Wall R20; **R6.7**



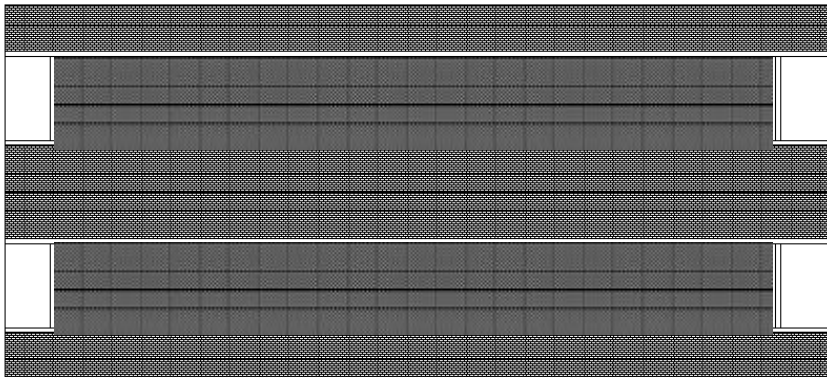
25% Fenestration

75% Wall

Window R2, Wall R20; **R6.2**

Window R2, Wall R40; **R7.0**

Window R4, Wall R20; **R10**



10% Fenestration

90% Wall

Window R2, Wall R20; **R10.5**

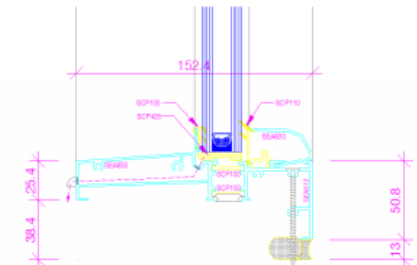
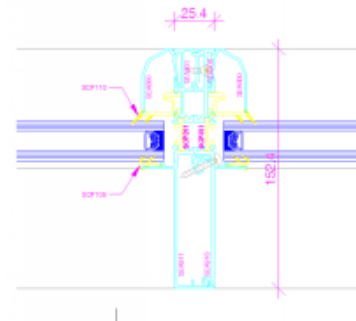
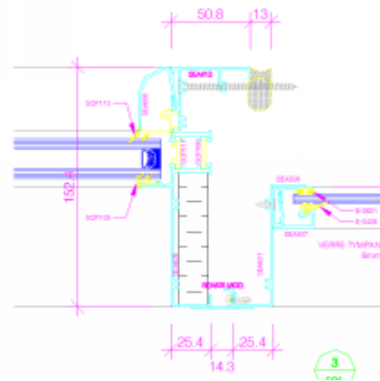
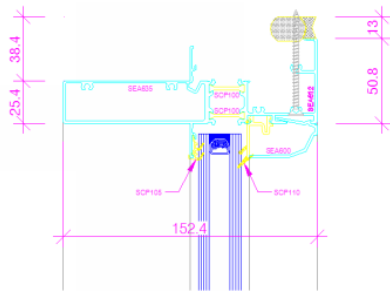
Window R2, Wall R40; **R13.8**

Window R4, Wall R20; **R14.3**

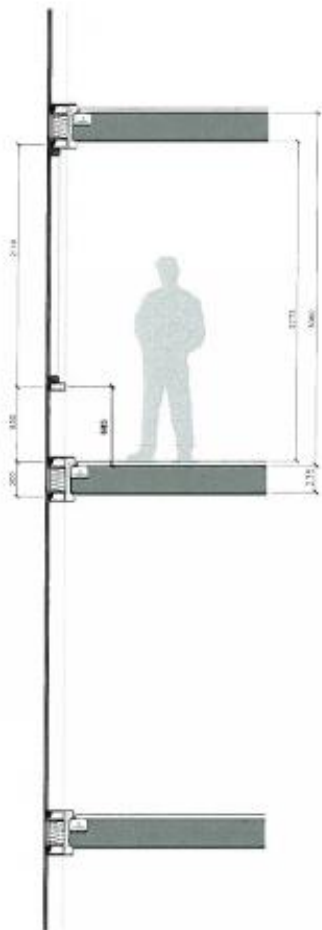
TYPICAL EFFECTIVE THERMAL RESISTANCE VALUES FOR WINDOWS

	R Value
Aluminum framed window with conventional thermal break and doubled glazed IGU composed of clear glass, metallic spacer and 12mm air space;	2.0
Aluminum framed window with conventional thermal break and doubled glazed IGU composed of clear glass with a high performance soft coat low-e, non-metallic spacer and 12mm argon filled air space;	3.0
Aluminum framed window with high performance thermal break and doubled glazed IGU composed of clear glass with a high performance soft coat low-e, non-metallic spacer and 12mm argon filled air space;	3.2
Aluminum framed window with high performance thermal break and tripled glazed IGU composed of clear glass with a high performance soft coat low-e on two surfaces, non-metallic spacer and two 12mm argon filled air spaces;	3.5
PVC framed window and doubled glazed IGU composed of clear glass with a high performance soft coat low-e, non-metallic spacer and 12mm argon filled air space;	3.5
PVC framed window and tripled glazed IGU composed of clear glass with a high performance soft coat low-e on two surfaces, non-metallic spacer and two 12mm argon filled air spaces;	5.7
Wood framed window and doubled glazed IGU composed of clear glass with a high performance soft coat low-e, non-metallic spacer and 12mm argon filled air space;	3.3
Wood framed window and tripled glazed IGU composed of clear glass with a high performance soft coat low-e on two surfaces, non-metallic spacer and two 12mm argon filled air spaces;	5.2
Fiberglass framed window and doubled glazed IGU composed of clear glass with a high performance soft coat low-e, non-metallic spacer and 12mm argon filled air space;	3.5
Fiberglass framed window and tripled glazed IGU composed of clear glass with a high performance soft coat low-e on two surfaces, non-metallic spacer and two 12mm argon filled air spaces	5.7

Energy star web site searches base on: Quebec, Operable casement.



SYSTÈME D'ENVELOPPE
OPTION 01 / MUR RIDEAU AVEC JOINTS DE SILICONE

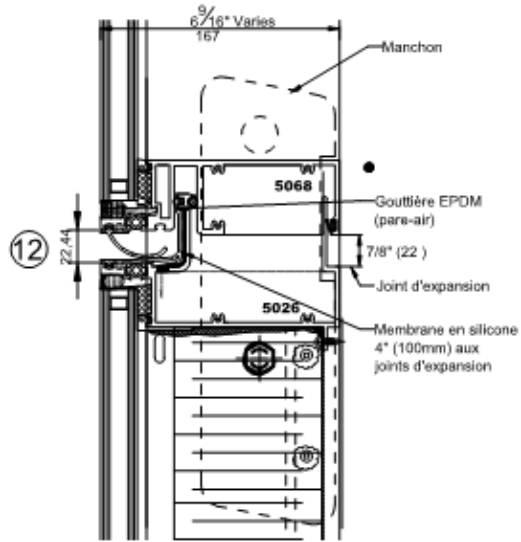
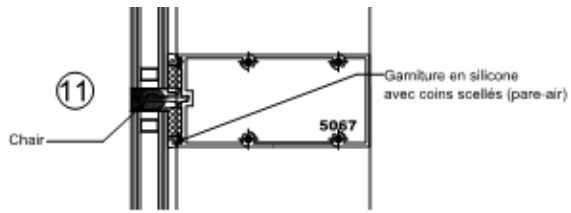


DÉTAIL EN COUPE / AA'
 ÉCHELLE: 1:20

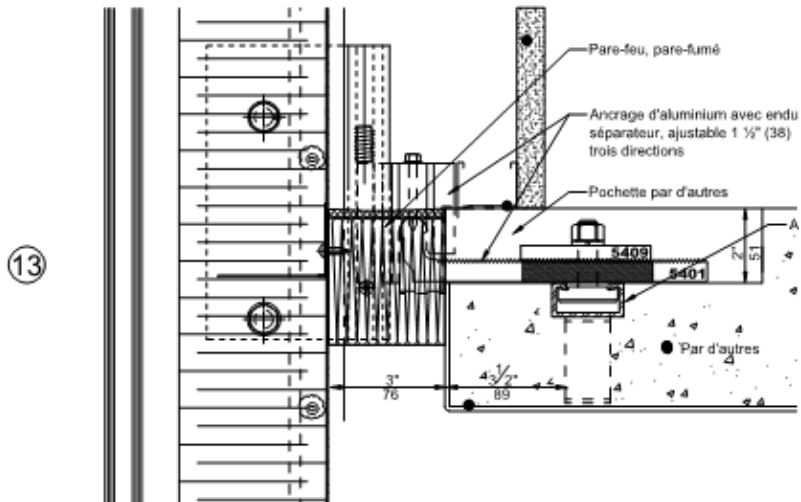


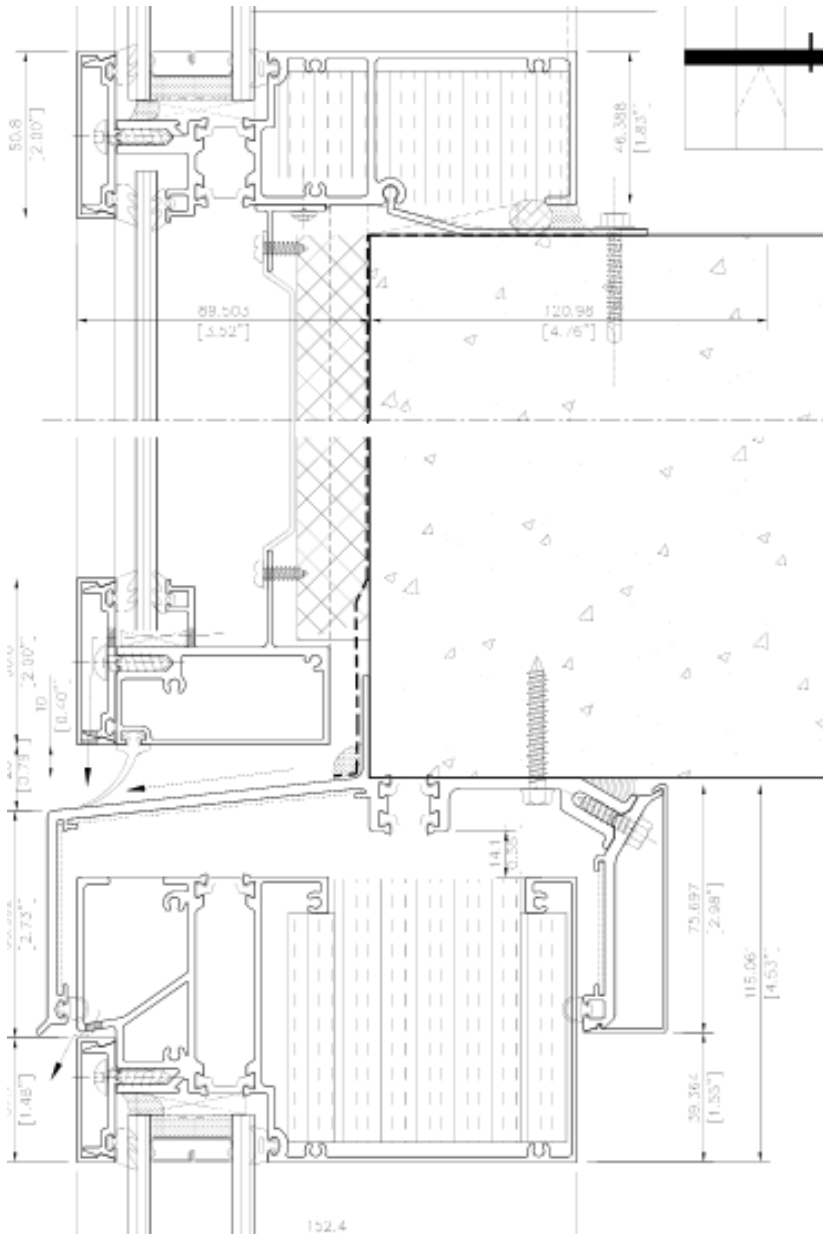
COUPE PERSPECTIVE

- A. "Shadow Box" / Gris clair + Verre clair sérigraphié
- B. "Shadow Box" / Gris moyen + Verre clair sérigraphié
- C. Verre clair / Opaque
- D. "Shadow Box" / Gris clair + Verre clair
- E. Verre clair / Fixe
- F. Louvre métallique / Gris moyen
- G. Louvre métallique / Gris foncé
- H. Verre clair sérigraphié / Fixe

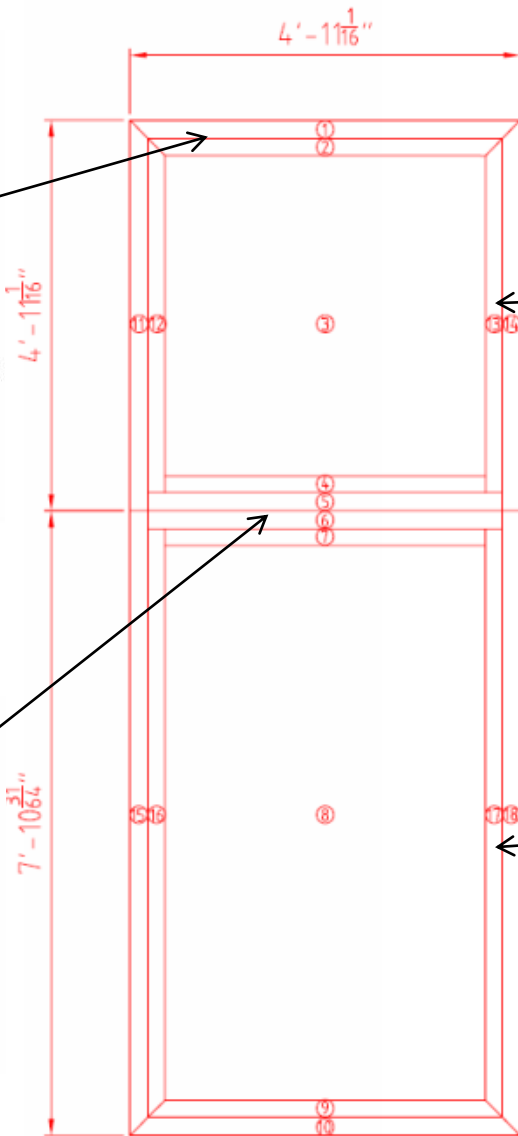
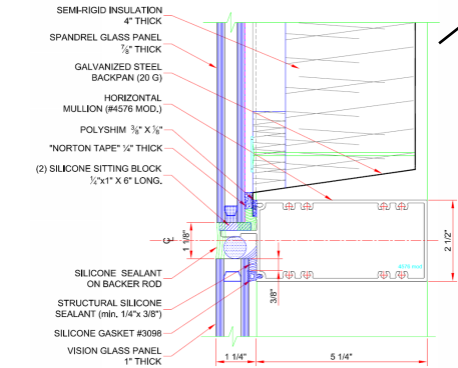
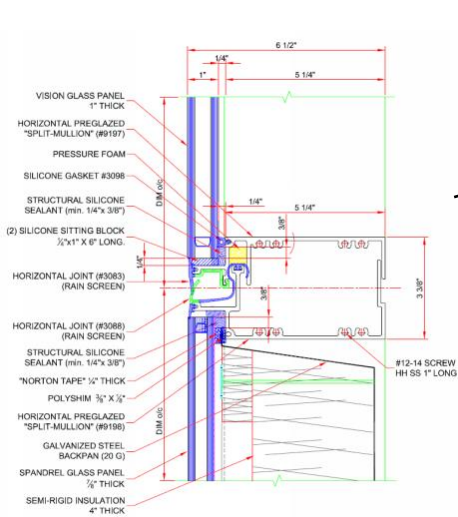


Trous de drain d'équilibre de p

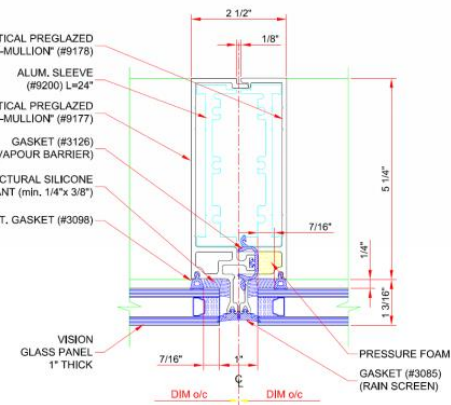
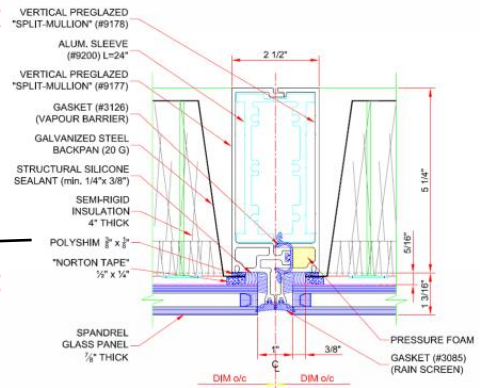








- ① DETAIL 100 - FRAME-OF-PANNE
- ② DETAIL 100 - EDGE-OF-PANNE
- ③ CENTRE-OF-PANNE
- ④ DETAIL 103 - EDGE-OF-PANNE
- ⑤ DETAIL 103 - FRAME-OF-PANNE
- ⑥ DETAIL 103 - FRAME
- ⑦ DETAIL 103 - EDGE-OF-GLAZING
- ⑧ CENTRE-OF-GLAZING
- ⑨ DETAIL 100 - EDGE-OF-GLAZING
- ⑩ DETAIL 100 - FRAME
- ⑪ DETAIL 101 - FRAME-OF-PANNE
- ⑫ DETAIL 101 - EDGE-OF-PANNE
- ⑬ DETAIL 101 - EDGE-OF-PANNE 2
- ⑭ DETAIL 101 - FRAME-OF-PANNE 2
- ⑮ DETAIL 102 - FRAME
- ⑯ DETAIL 102 - EDGE-OF-GLAZING
- ⑰ DETAIL 102 - EDGE-OF-GLAZING 2
- ⑱ DETAIL 102 - FRAME 2



Overall U-value typical unitized CW module

Results for Vision with Framing for Proposed Spandrel System

Overall U-factor for Vision with Framing (Project:)											
#	Unit	# of Units	Width [inch]	Length [inch]	Area (A) [ft ²]	#*A [ft ²]	U-Factor (U) [Btu/(hr-ft ² -°F)]	#*(AU) [Btu/(hr-°F)]	Overall U-Factor [Btu/(hr-ft ² -°F)]	R-Value [(hr-ft ² -°F)/Btu]	RSI-Value [(m ² -°C)/W]
6	DETAIL 103 - FRAME	1	1,28	59,063	0,50	0,50	1,9155	0,96			
7	DETAIL 103 - EDGE-OF-GLAZING	1	2,50	59,063	0,89	0,89	0,2815	0,25			
8	CENTRE-OF-GLAZING	1	51,49	86,52	30,94	30,94	0,255	7,89		R3.9	
9	DETAIL 100 - EDGE-OF-GLAZING	1	2,50	59,063	0,94	0,94	0,2751	0,26			
10	DETAIL 100 - FRAME	1	1,68	59,063	0,67	0,67	1,6350	1,10			
15	DETAIL 102 - FRAME	1	1,29	94,484	0,84	0,84	1,6668	1,40			
16	DETAIL 102 - EDGE-OF-GLAZING	1	2,50	94,484	1,57	1,57	0,2623	0,41			
17	DETAIL 102 - EDGE-OF-GLAZING 2	1	2,50	94,484	1,57	1,57	0,2624	0,41			
18	DETAIL 102 - FRAME 2	1	1,28	94,484	0,83	0,83	1,6817	1,40			
	Total	9				38,75		14,1	0,3634	2,75	0,48

Results for Proposed Spandrel with Framing

Overall U-factor for Proposed Spandrel with Framing (Project:)											
#	Unit	# of Units	Width [inch]	Length [inch]	Area (A) [ft ²]	#*A [ft ²]	U-Factor (U) [Btu/(hr-ft ² -°F)]	#*(AU) [Btu/(hr-°F)]	Overall U-Factor [Btu/(hr-ft ² -°F)]	R-Value [(hr-ft ² -°F)/Btu]	RSI-Value [(m ² -°C)/W]
1	DETAIL 100 - FRAME-OF-PANNE	1	1,67	59,063	0,67	0,67	0,9331	0,63			
2	DETAIL 100 - EDGE-OF-PANNE	1	2,50	59,063	0,94	0,94	0,2866	0,27			
3	CENTRE-OF-PANNE	1	51,56	51,14	18,31	18,31	0,0490	0,90		R20.4	
4	DETAIL 103 - EDGE-OF-PANNE	1	2,50	59,063	0,90	0,90	0,2794	0,25			
5	DETAIL 103 - FRAME-OF-PANNE	1	1,25	59,063	0,49	0,49	1,0410	0,51			
11	DETAIL 101 - FRAME-OF-PANNE	1	1,25	59,063	0,51	0,51	1,3188	0,67			
12	DETAIL 101 - EDGE-OF-PANNE	1	2,50	59,063	0,95	0,95	0,3050	0,29			
13	DETAIL 101 - EDGE-OF-PANNE 2	1	2,50	59,063	0,95	0,95	0,3112	0,30			
14	DETAIL 101 - FRAME-OF-PANNE 2	1	1,25	59,063	0,51	0,51	1,3115	0,66			
	Total	9				24,22		4,5	0,1845	5,42	0,95

Results for Vision and Spandrel with Framing for Proposed Spandrel System

Overall U-factor for a Typical Unit with Proposed Spandrel (Project:)											
#	Unit	# of Units	Width [inch]	Length [inch]	Area (A) [ft ²]	#*A [ft ²]	U-Factor (U) [Btu/(hr-ft ² -°F)]	#*(AU) [Btu/(hr-°F)]	Overall U-Factor [Btu/(hr-ft ² -°F)]	R-Value [(hr-ft ² -°F)/Btu]	RSI-Value [(m ² -°C)/W]
1	DETAIL 100 - FRAME-OF-PANNE	1	1,67	59,063	0,67	0,67	0,9331	0,63			
2	DETAIL 100 - EDGE-OF-PANNE	1	2,50	59,063	0,94	0,94	0,2866	0,27			
3	CENTRE-OF-PANNE	1	51,56	51,14	18,31	18,31	0,0490	0,90		R20.4	
4	DETAIL 103 - EDGE-OF-PANNE	1	2,50	59,063	0,90	0,90	0,2794	0,25			
5	DETAIL 103 - FRAME-OF-PANNE	1	1,25	59,063	0,49	0,49	1,0410	0,51			
6	DETAIL 103 - FRAME	1	1,28	59,063	0,50	0,50	1,9155	0,96			
7	DETAIL 103 - EDGE-OF-GLAZING	1	2,50	59,063	0,89	0,89	0,2815	0,25			
8	CENTRE-OF-GLAZING	1	51,49	86,52	30,94	30,94	0,255	7,89		R3.9	
9	DETAIL 100 - EDGE-OF-GLAZING	1	2,50	59,063	0,94	0,94	0,2751	0,26			
10	DETAIL 100 - FRAME	1	1,68	59,063	0,67	0,67	1,6350	1,10			
11	DETAIL 101 - FRAME-OF-PANNE	1	1,25	59,063	0,51	0,51	1,3188	0,67			
12	DETAIL 101 - EDGE-OF-PANNE	1	2,50	59,063	0,95	0,95	0,3050	0,29			
13	DETAIL 101 - EDGE-OF-PANNE 2	1	2,50	59,063	0,95	0,95	0,3112	0,30			
14	DETAIL 101 - FRAME-OF-PANNE 2	1	1,25	59,063	0,51	0,51	1,3115	0,66			
15	DETAIL 102 - FRAME	1	1,29	94,484	0,84	0,84	1,6668	1,40			
16	DETAIL 102 - EDGE-OF-GLAZING	1	2,50	94,484	1,57	1,57	0,2623	0,41			
17	DETAIL 102 - EDGE-OF-GLAZING 2	1	2,50	94,484	1,57	1,57	0,2624	0,41			
18	DETAIL 102 - FRAME 2	1	1,28	94,484	0,83	0,83	1,6817	1,40			
	Total	18				62,98		18,6	0.2946	3.39	0.60

Don't forget to control
air leakage!



HISTORIC
CON MINE
CABIN

Built in 1930 this log cabin
was used to store explosives
for the mine.

Preserved and maintained by the
NWT Mining Heritage Society





CARRIÈRE & LEFÈVRE
381-7456

Depuis 1958
CARRIÈRE & LEFÈVRE
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Depuis 1958
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MARCEL BENOIT
667-6000

CARRIÈRE & LEFÈVRE
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Depuis 1958

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AIR-GARD

MARCEL BENOIT
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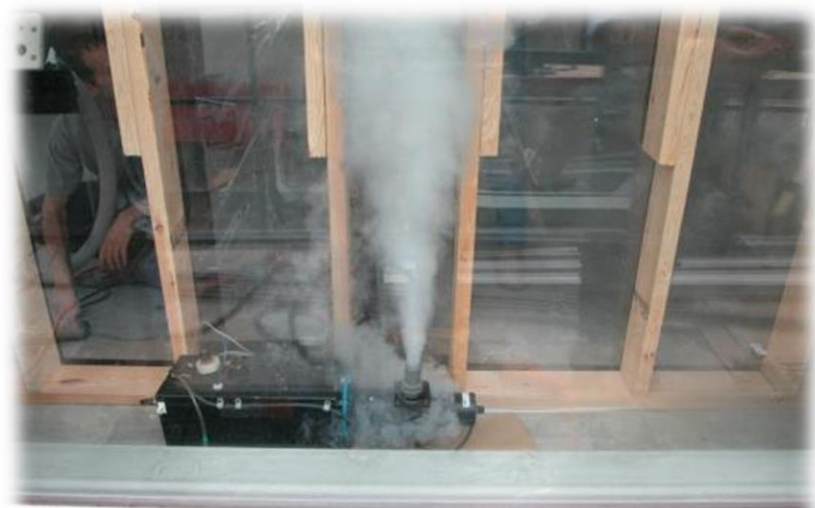
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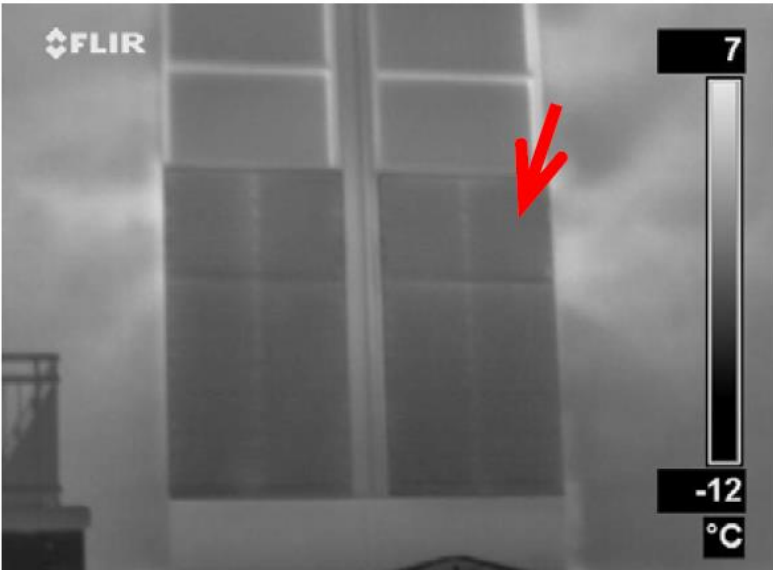


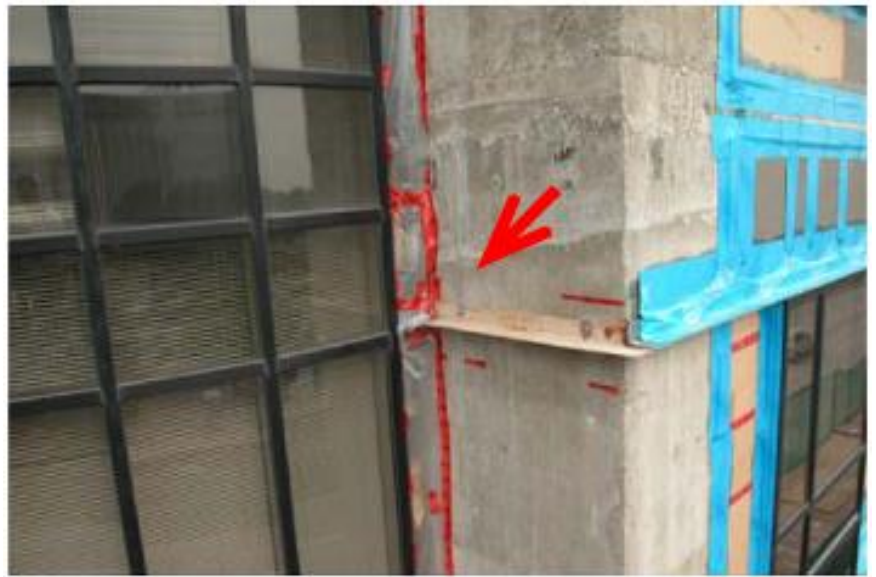
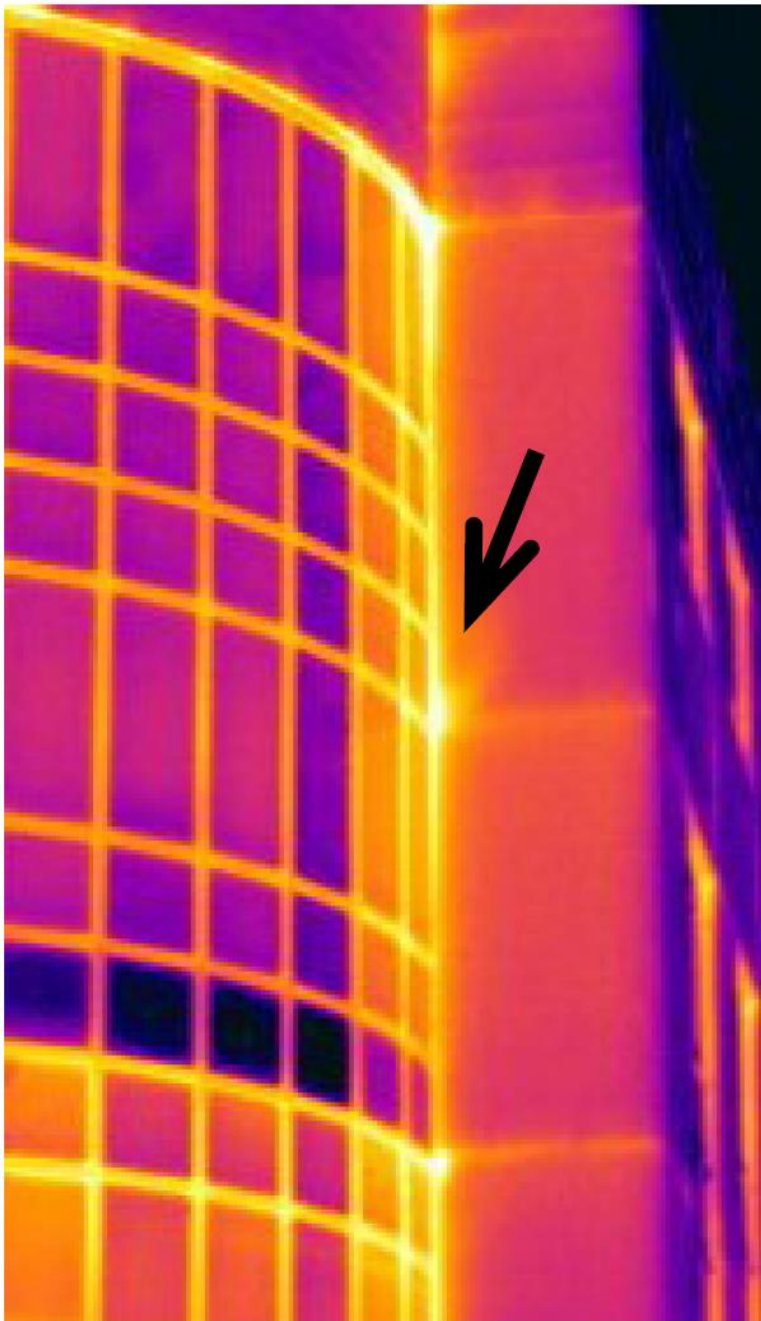


ED
PANEL

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So, what would be the overall thermal performance for this stock of buildings?



THANK YOU!
mgoncalves@cleb.com