



Winner of the Greenest School in Canada 2017:
Amber Trails Community School



High Performance Glazing

Technologies, Applications & Resulting Performance

Presented by Al Dueck, DUXTON Windows & Doors



In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

“This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1 hour** of credit toward **Building Officials and Residential Contractors code /1 hour energy** continuing education requirements.”

For additional continuing education approvals, please see your credit tracking card.

Overview

- Breakdown of high performance window components
- Meeting performance in large window assemblies
- Trade-offs of new glazing options
 - Quads, multi-film units, vacuum insulated
- Project examples



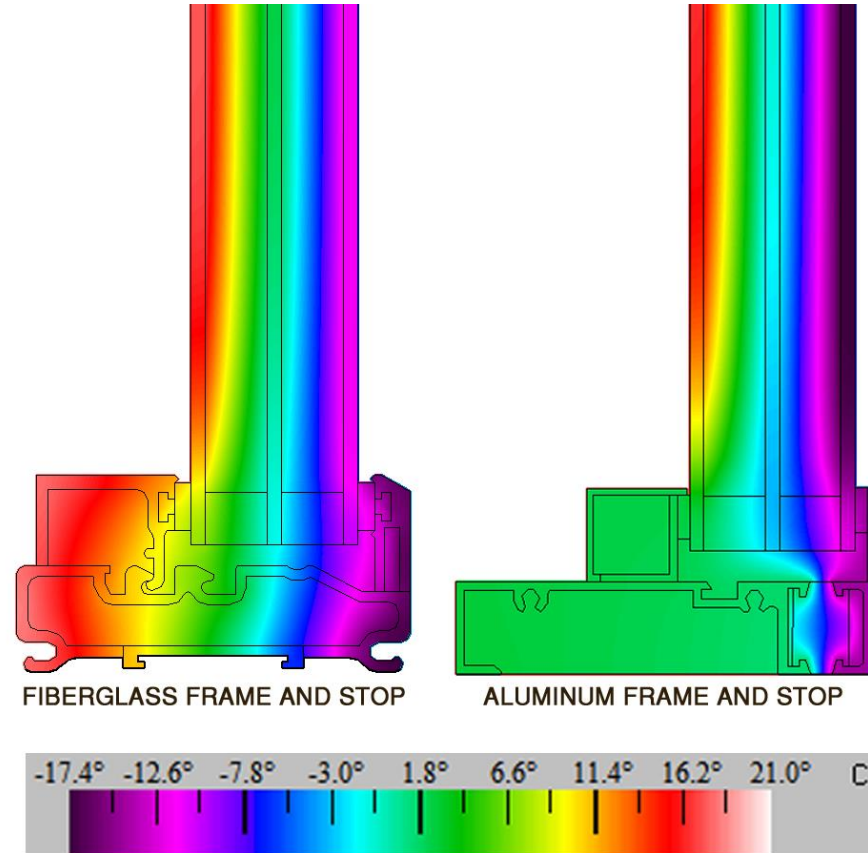
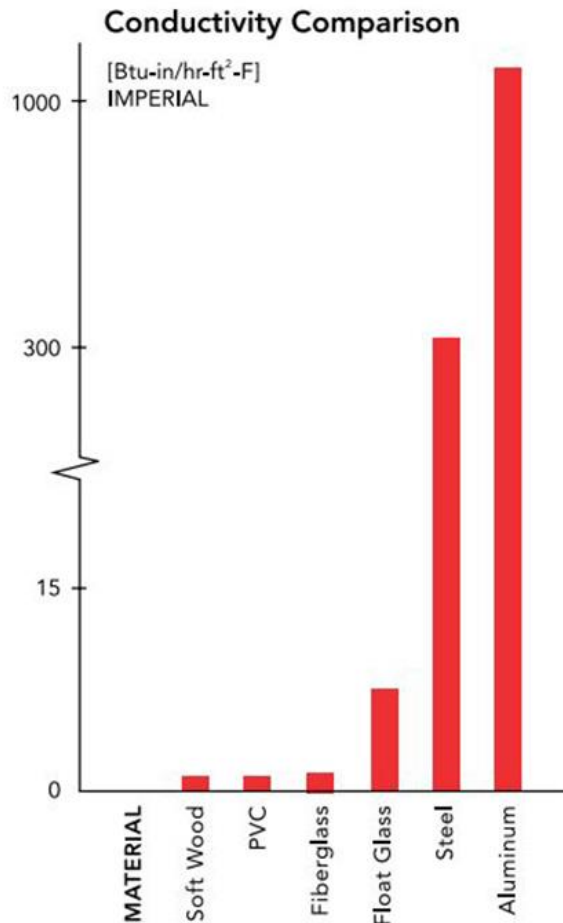
Passive House, BridgmanCollaborative Architecture

High Performance Window Components

- ✓ Non-conductive insulated frame
- ✓ Strength achieved with minimal steel reinforcing
- ✓ Low-e coatings, with solar gain design
- ✓ Air/argon/krypton gas fill
- ✓ Optimized air spaces
- ✓ Multiple cavities
- ✓ Air tightness while having fresh air access

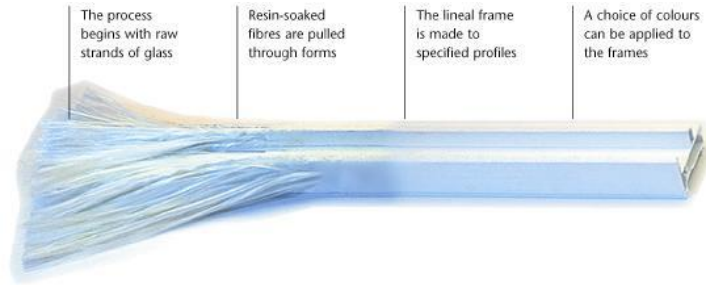


Non-Conductive Insulated Frame



Both simulated with a Tri-pane 2 Low-E Silver Coatings (2&5), Argon, Warm Edge Spacer

Non-Conductive Insulated Frame Pultruded Fiberglass



Mechanical puller pulling glass content through die with resin matrix

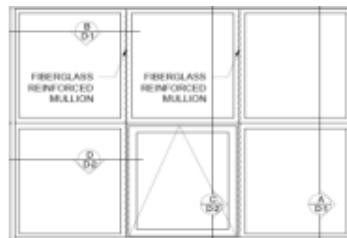


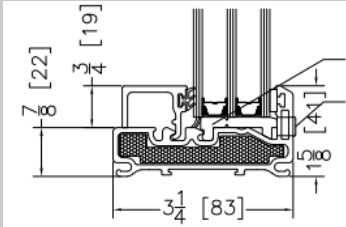
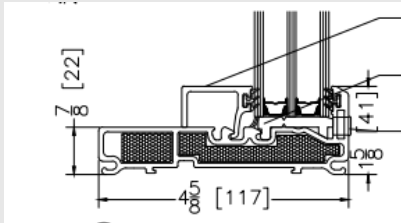
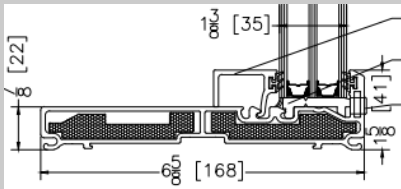
Glass rovings and matting before “collection”






Strength Achieved with Minimal Steel

Sample Window:
8'x6'



Series	Cross Section	Performance Grade
328 or 3 1/4"		LC 40
458 or 4 5/8"		LC 55 (or CW 35)
658 or 6 5/8"		CW 60

Strength Achieved with Minimal Steel

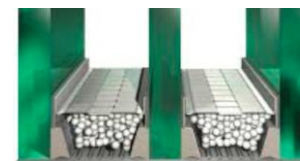
Series	Application
<p>328 or 3 1/4"</p> <p><i>Approx. 5x4'</i></p>	
<p>458 or 4 5/8"</p> <p><i>Approx. 6x8'</i></p>	
<p>658 or 6 5/8"</p> <p><i>Approx. 80x12'</i></p>	

Air, Argon, Krypton Gas Fill

3-Pane LoE ² ® -272 #2 & LoE-180 #5						
Spacer	U-Values (Btu/hr/ft ² /°F)/					
	Center of Glass Temperatures					
	Air/U	Temp.	Argon/U	Temp.	Kr/U	Temp.
6.5mm	0.248	55.9	0.194	58.7	0.130	62.2
7.0mm	0.236	56.5	0.184	59.3	0.124	62.5
7.5mm	0.225	57.1	0.175	59.7	0.120	62.8
8.0mm	0.215	57.6	0.168	60.1	0.116	63.0
9.8mm	0.188	59.1	0.147	61.3	0.113	63.2
11.2mm	0.173	59.9	0.136	61.9	0.115	63.0
11.5mm	0.171	60.0	0.134	62.0	0.115	63.0
12.2mm	0.165	60.3	0.131	62.2	0.116	63.0
13.0mm	0.161	60.5	0.129	62.3	0.118	62.9

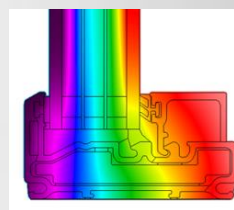
Meaning:

- 1 3/8" overall for best performance in argon
- Krypton offers further insulating value with narrower air spaces
- Thicker glass reduces performance in the same OD

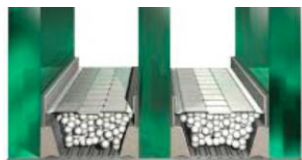


Multiple Cavities

Value Considerations



Glass type	Gas	OD	Centre-of-Glass				Overall Window	Pricing (USD)	Limited Warranty
			R-Value	U-Value	Heat Gain	Visible Light	U-Value (imperial)	Glass \$/sq. ft.	
Dual Pane									
1 Low-E, mid-range heat gain	Argon	1 3/8"	4.00	0.25	0.41	72%	0.27	\$ 8.08	20 years
Triple Pane									
2 Low-Es, mid-range heat gain	Argon	1 3/8"	7.69	0.13	0.37	63%	0.16	\$ 16.61	20 years
Thin Glass Quads									
2 Low-Es, mid-range heat gain	Krypton	1 3/8"	10.00	0.10	0.35	58%	0.12	\$ 33.94	10 years
Suspended Film							<i>*Estimated</i>		
4 layers of film	Air	4.41"	12.00	0.08	0.26	43%	0.10	\$ 58.91	25 years
Vacuum Insulated Sealed Unit							<i>*Estimated</i>	<i>*Estimated</i>	
VIG assembled into SU, low heat gain	Air	0.96"	14.10	0.07	0.27	54%	0.09	\$ 50.00	N/A
<i>Notes: Simulations based on 4 mm pane thickness. NFRC conditions.</i>									



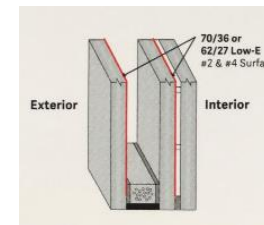
Conventional triple



Thin glass



Multi-film



Vacuum Insulated Unit

Air Tightness with having Fresh Air Access

Virtually all operable windows creates LOTS of cooling air flow



Slim Sash



Extensive use of venting fenestration allows for a naturally cooled interior

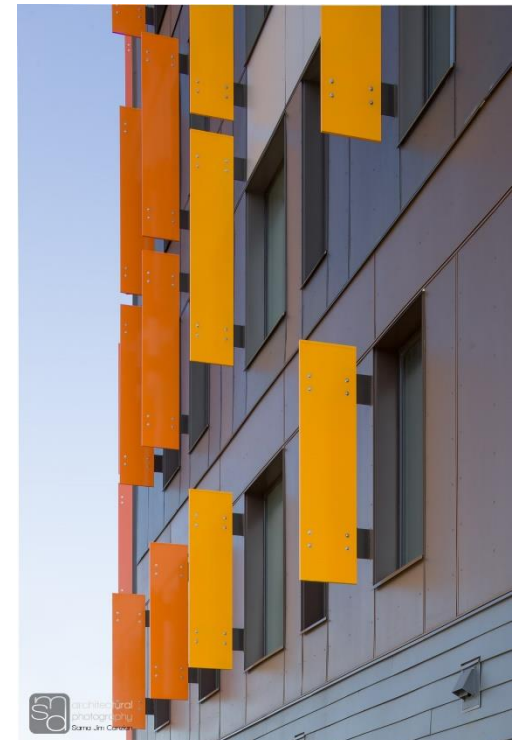


Project Examples

Largest Passive Housing in British Columbia



- LARGE outward opening awnings with multi point locks
- Triple glazing with double low e/krypton
- “Mid wall” installation with clips



Adapting High Performance systems Light Commercial Retrofit in Wisconsin



More practical installation/interior glazing



Adapting High Performance systems

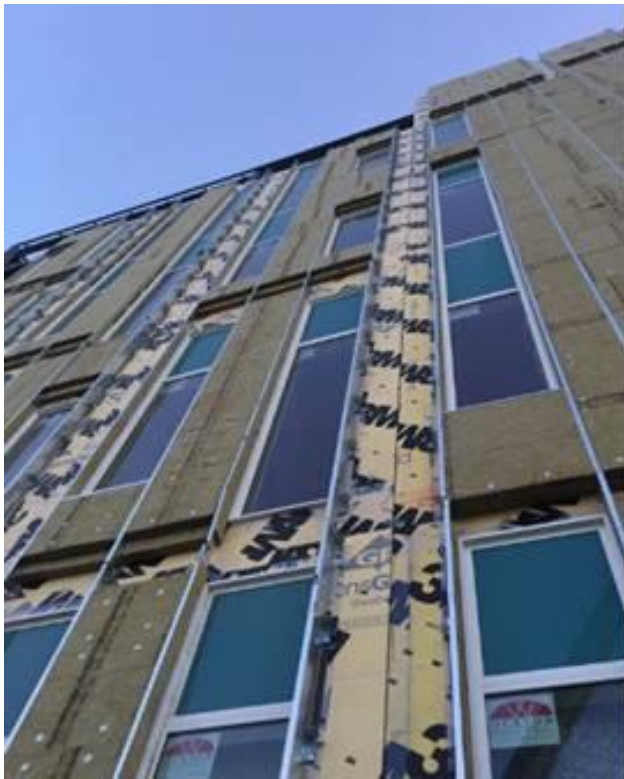
University Residence with Insulated/Venting Louvers



Adapting High Performance systems

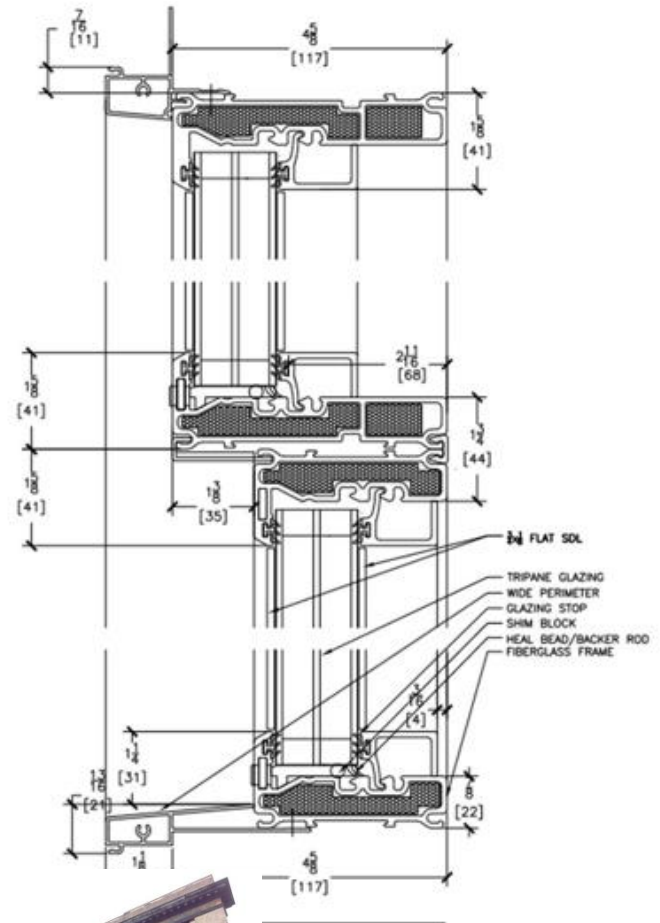
Pre-fab panel/installed windows assembly in Northern Canada

*Pre “orchestrated” installation
Detailing and site handling*



Adapting High Performance systems

Single/Double Hung Replacement for Historic Buildings/Winnipeg



Adapting High Performance systems

Floor to Ceiling combinations in South Minnesota Residence

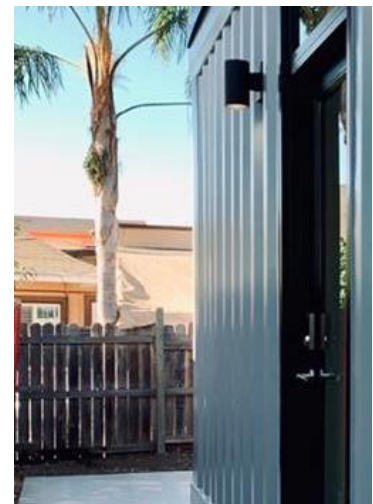
Sliding doors, FiberWall fixed and outward venting units



Adapting High Performance systems

Adapted for installation in recycled Shipping Containers

Sliding doors, FiberWall fixed and sliding venting units



Adapting High Performance systems

FRP WindowWall with outward opening fresh air access



Educational Institutions with Security Screens

- Much “cleaner” glass protection
- Less “jail like” in perception
- Cleaning access possible



Learning from our VERY Small World

Cycling in Copenhagen

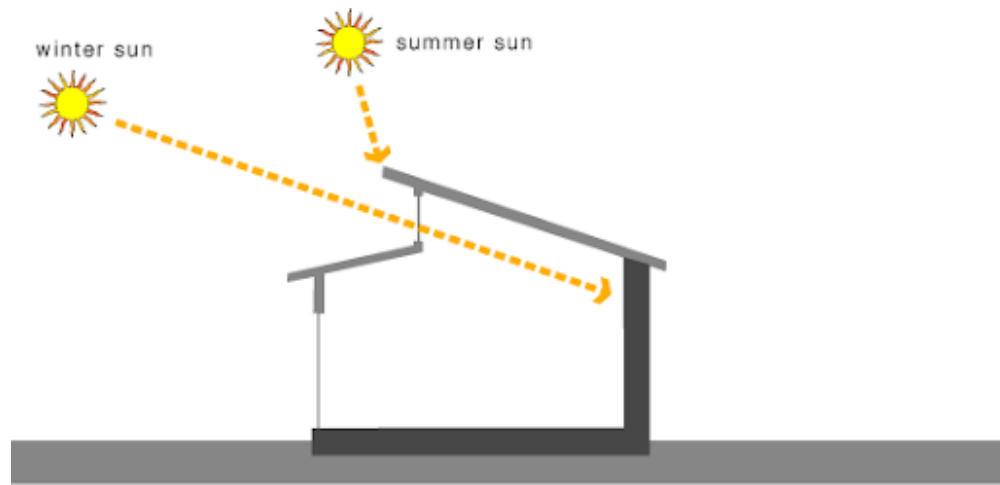


Learning from our VERY Small World

Cycling in Helsinki : New “library”

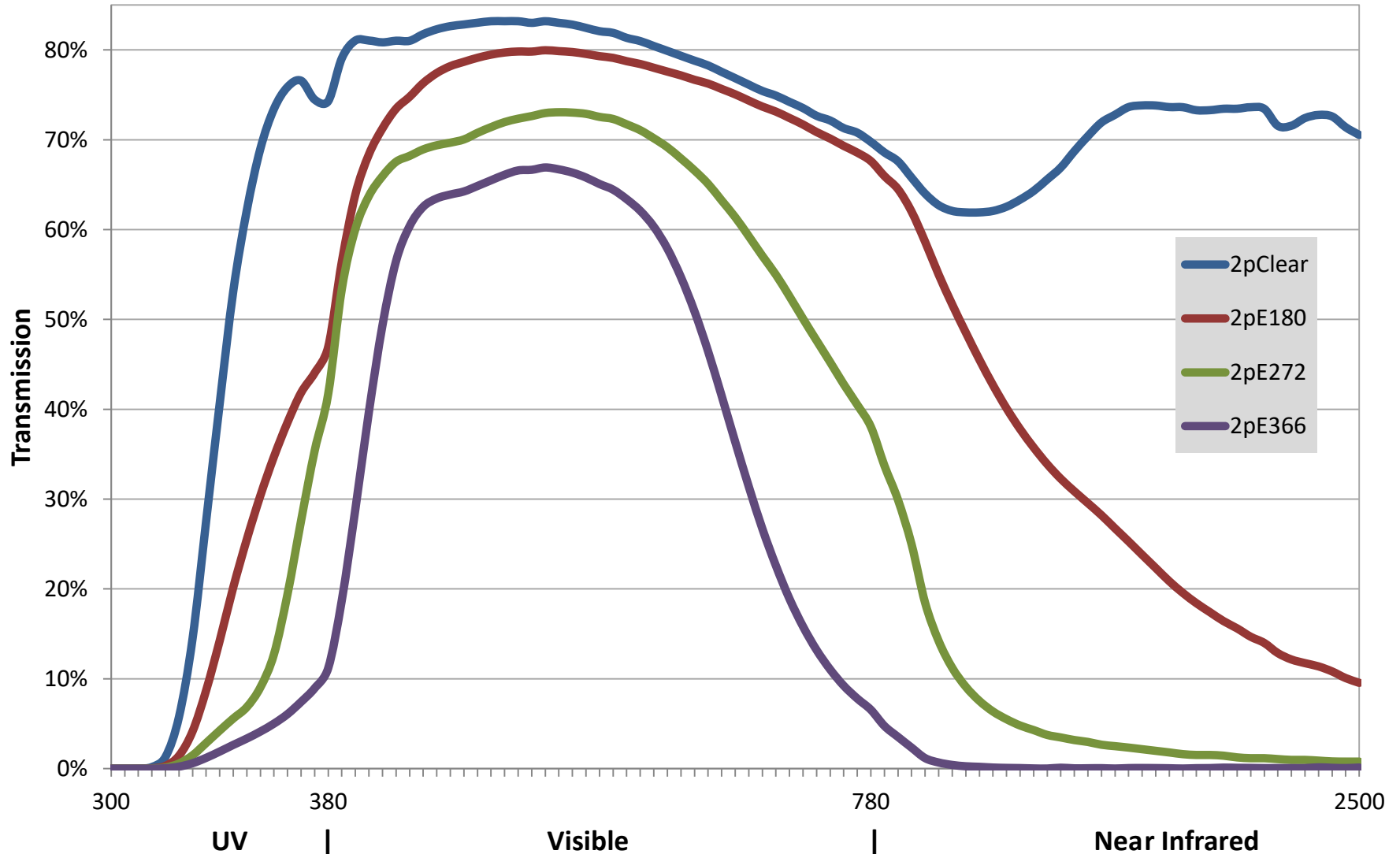


Solar “Optimization”



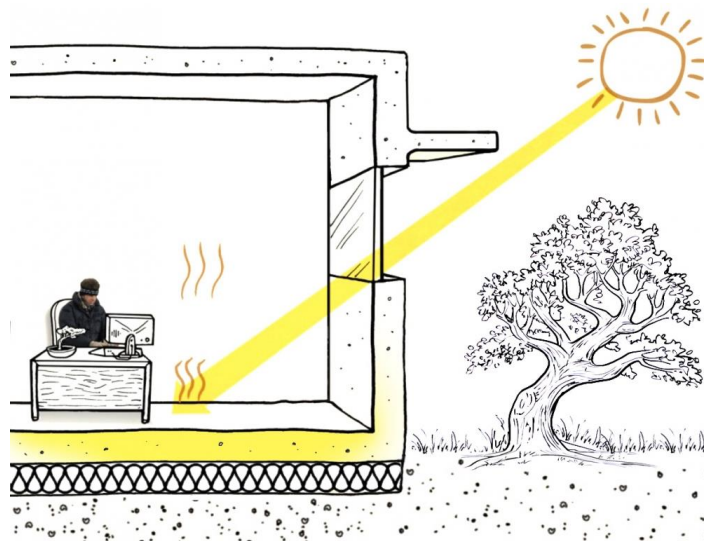
Spectrally Selective LoE Coatings

% Transmission per Wavelength



How do Windows Contribute to Overall Building Performance?

- Windows in the U.S. consume 30% building heating and cooling energy
- Focus on the building envelope 1st – heating & cooling 2nd
- Windows can be “net energy gainers” with passive solar design

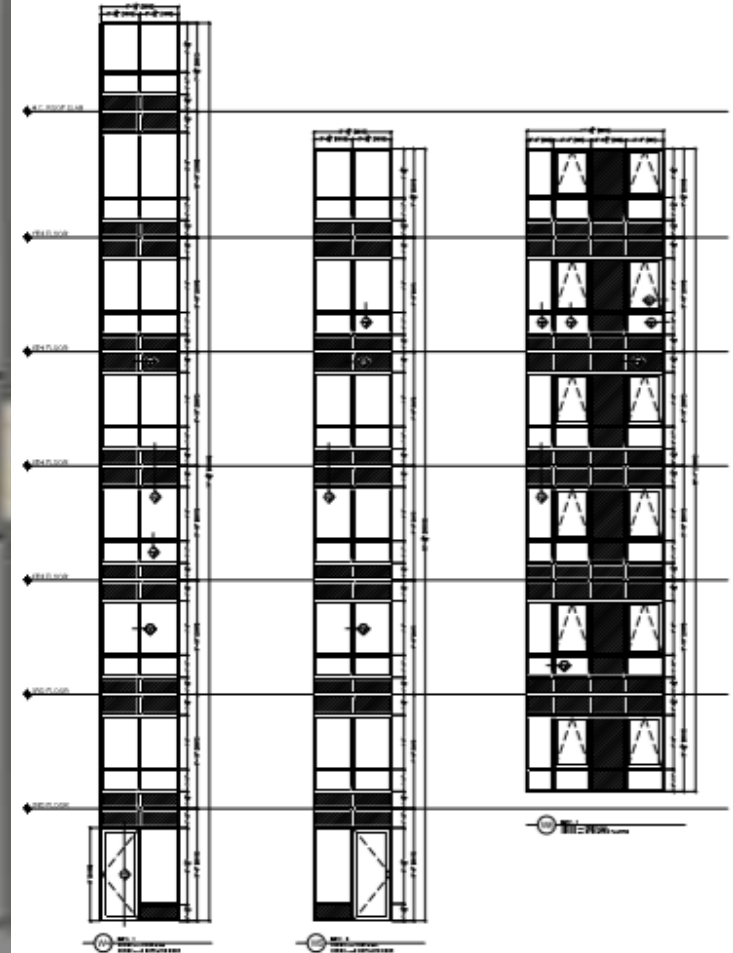


2014 Austrian Opera Center South Central Europe with Triple glass



Strip window Installation Options

Left : 10 yr old installation Wpg Mid: Fire Rated Resin System Right : Strip Install



Educational with Security Screens

Options including much more subtle glass protection screens



School Fenestration Hopper Option

Tilt n' Turn

- European style, inward opening
- Triple option, TIGHTER seal
- Opens for venting or entry



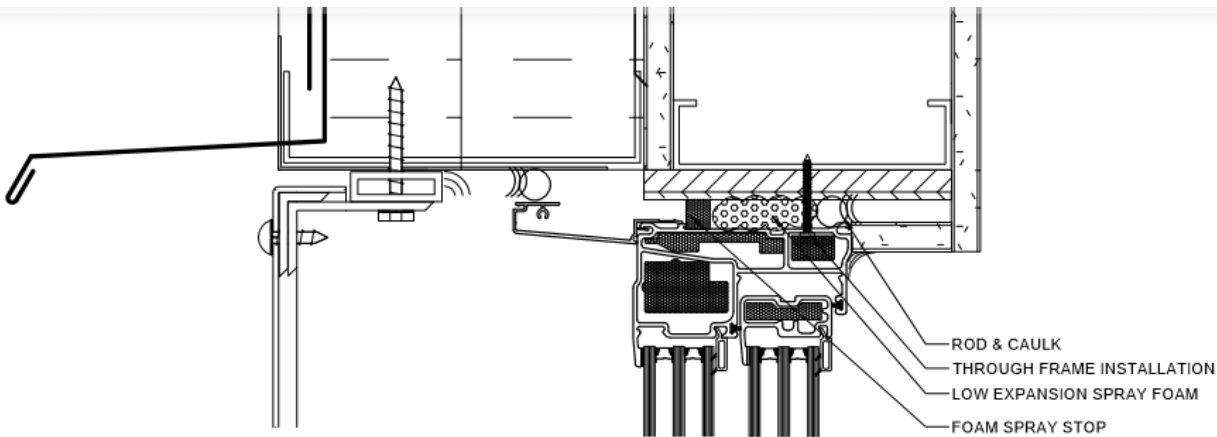
School Fenestration Hopper Option

Tilt n' Turn

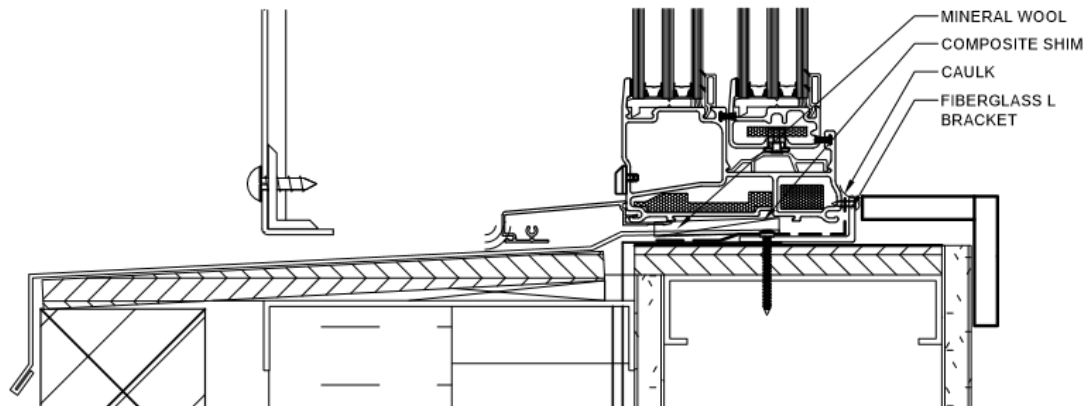


Cold Climate, Rain Screen Install Detail

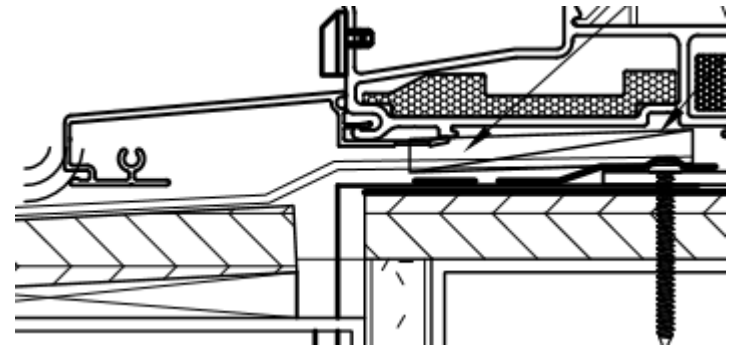
Properly prepared/sealed rough opening protects building envelope while exterior gaps allow drainage to exterior/opportunity for drying to take place. Rocksul insulation on sill and low expansion foam on sides and top.



Fiberglass L bracket on interior provides 1" tall barrier to water entry with silicone seal



250 Pan accessory overlaps sill flashing under window





Thank You

Questions?



National Building Code

Energy Code Benchmarks

City	Zone	Prescriptive Max U-Value <i>W/m²K (imperial/btu)</i>
Commercial: MB (2011)	7A	2.00 (0.35)
Commercial: AB/SK (2015/2017)	7A	2.20 (0.39) to 1.90 (0.33)

Centre of Glass (COG) vs. Overall U-value

Glazing	Centre of Glass	Aluminum No Thermal Break	Aluminum Thermal Break	PVC/ FG Picture	PVC/ FG Slider
Dual Clear	2.65	4.85	3.20	2.50	2.50
Dual Low-E Hard Coat	1.60	4.00	1.90	1.70	1.95
Dual Low-E Soft Coat	1.35	3.20	1.85	1.60	1.65
Tri Low-E Hard Coat	1.00	3.60	1.40	1.35	1.80
Tri Low-E 2*Soft Coat	0.85	3.60	1.05	0.95	1.36

Overall U-Values

How does a 3 mm triple compare to a 5/6 mm triple?

Product	Glazing	Uwindow [W/m ² *K]	Uwindow [btu/h*ft ² *F]
FiberWall 328 Fixed	3mm/366/Arg90/3mm/Arg90/180/3mm - 1.375	0.853	0.1502
FiberWall 328 Fixed	6mm/366/Arg90/6mm/Arg90/180/6mm - 1.375	1.018	0.1793
FiberWall 328 Fixed	6mm/366/Arg90/6mm/Arg90/180/6mm - 1.5	0.978	0.1722
FiberWall 328 Fixed	6mm/366/Arg90/6mm/Arg90/180/6mm - 1.25	1.107	0.1950

R: Single family homes.
Minimum PG-15

LC: Low or mid-rise multi-family. Larger sizes, higher loading requirements.
Minimum PG-25

CW: Mid-rise buildings. Larger sizes, higher loading requirements,
limits on deflection, and heavy use.
Minimum PG-30

AW: Mid or high-rise buildings. Appropriate where frequent and extreme use of product
is expected.
Minimum PG-40

NAFS – Building Code Requirement

Single Storey Saskatoon Example

www.fenestrationcanada.ca/calculator

Compare to A3/B7/C5 Spec:

where

province

city

location

product height metres
above ground to top of product

terrain type^A ☒ open ☐ rough



performance requirements

minimum performance grade (PG)^B

minimum positive design pressure PA

minimum negative design pressure PA

minimum water penetration resistance test pressure PA

minimum canadian air infiltration/exfiltration^C



PG-70

3360 PA

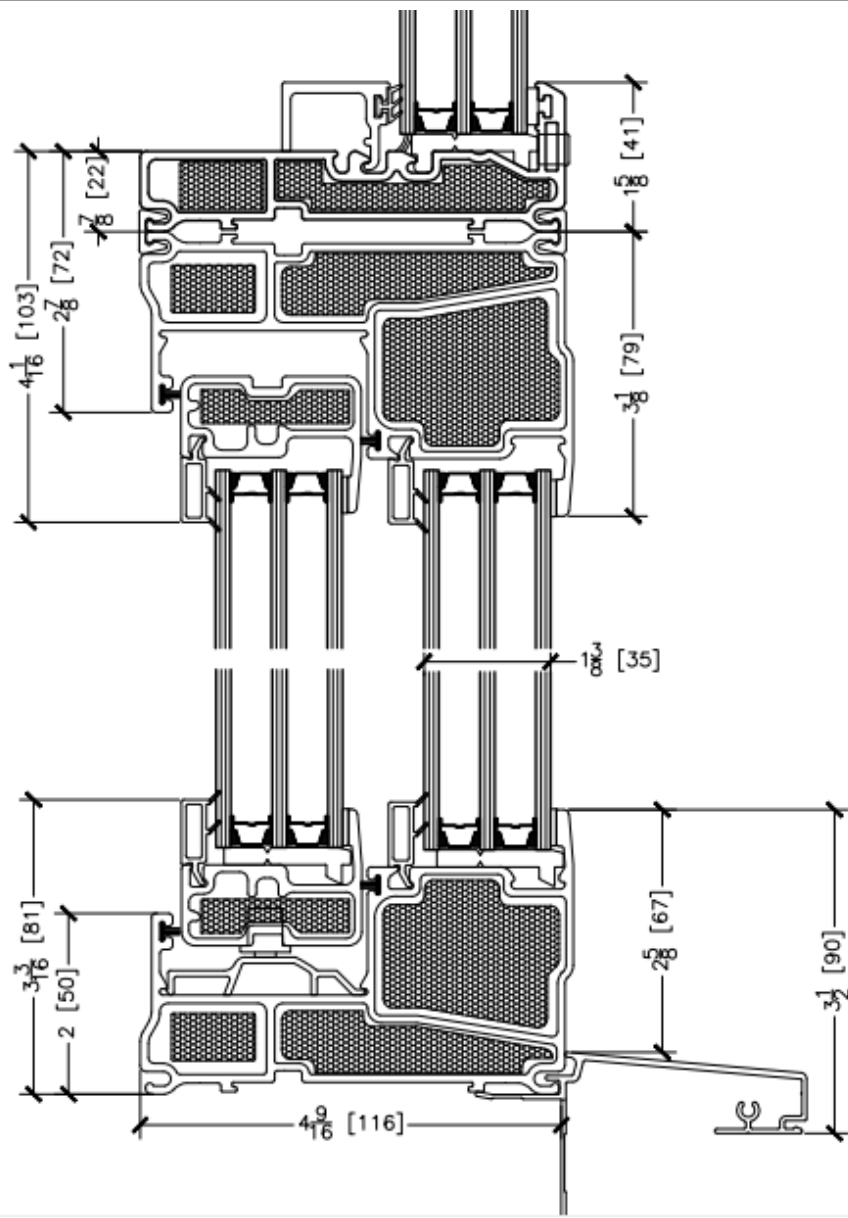
3360 PA

700 PA

A3

Product Design for Thicker Glazing

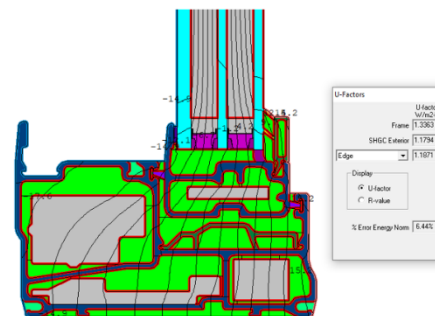
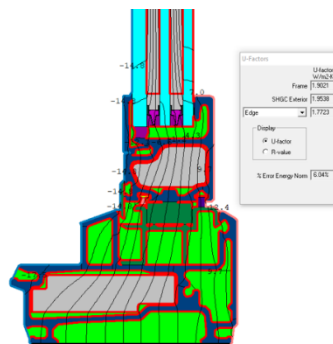
Slider accommodates High Performance 6 mm Triples



Thermal Comparison: 458 Slider Triple vs 800 Series Slider Triple

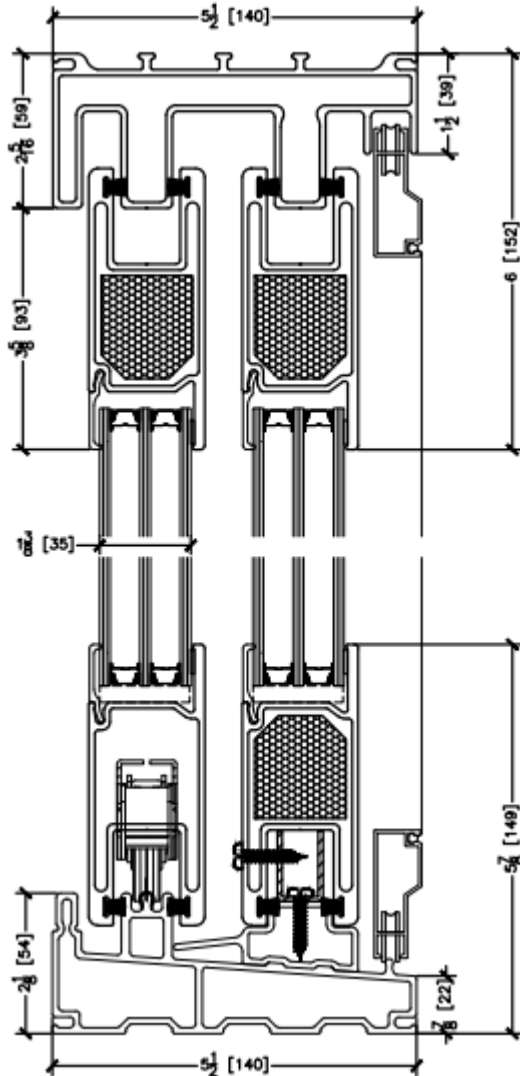
Glazing type: 6mm 180/4mm/4mm 180 (90% Arg)

Component	U [w/m ² K] 458 Slider (1.375" OD)	U [w/m ² K] 800 Series Slider (0.9375" OD)	% Improvement over 800 Series
Center of Glass	0.826	1.368	39.6%
Overall Window	1.132	1.608	29.6%

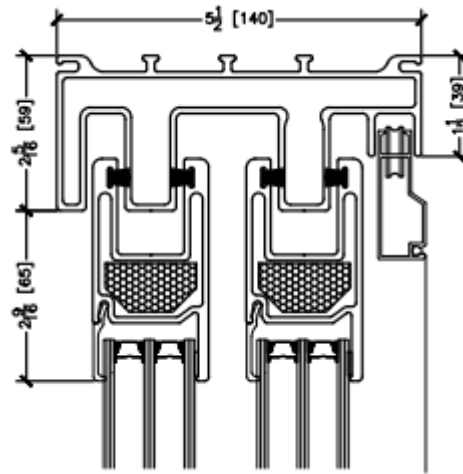


Product Design for Multi-Family Applications

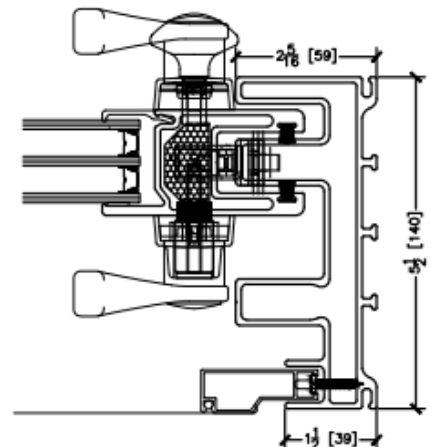
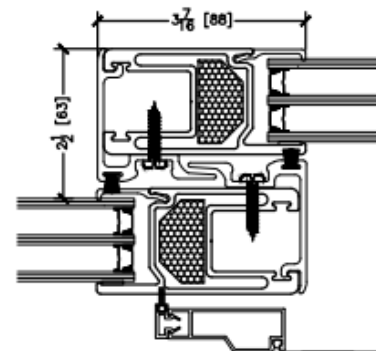
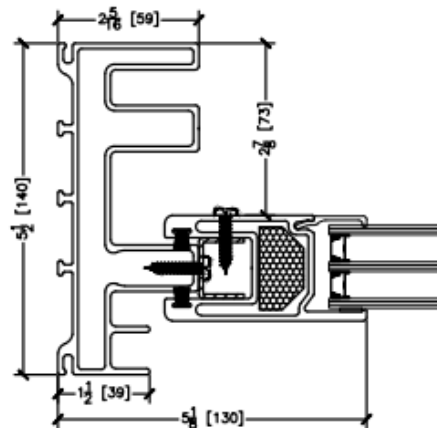
Sliding Door for Superior Air, Water, Structural, and U-Value Performance



Regular Sash



Slim Sash



Living Building Challenge Favours Fiberglass

Wolf Ridge Environmental Learning Center



Declare.

FiberWall™ Series 458FX DUXTON Windows & Doors

Final Assembly: Winnipeg, MB, Canada
Life Expectancy: 30 Years (Mfg Warranty: 20 Years)
End of Life Options: Recyclable (93% where recycling facilities exist), Landfill (7%)

Ingredients:

Float Glass; Glass Coating: Zinc Oxide; Inert Gas Fill: Argon; IG Spacers: Iron, Chromium, Manganese, Nickel, Silicon, Molybdenum, Copper; Frame/Sash Pultrusions: Glass Fibers/ Glass Strand Mats, Polyester Resin, Styrene, Polyethenyl Acetate, Di-(4-Tert-Butylcyclohexyl Peroxydicarbonate), Tert-Butylperoxy-2-Ethylhexanoate, Fatty Acid Esters (Oil), Calcium Carbonate, Clay (Alumina); Shear Blocks: Polyamide, Fiberglass Wool; Foam Insulation: Polystyrene Thermoplastic; Glazing Stops: Glass Fibers/Glass Strand Mats, Polyester Resin, Styrene, Polyethenyl Acetate, Di-(4-Tert-Butylcyclohexyl Peroxydicarbonate), Tert-Butylperoxy-2-Ethylhexanoate, Fatty Acid Esters (Oil), Calcium Carbonate, Clay (Alumina); Glazing Rubber: EPDM, Polypropylene; Nailing Fin & Brickmould Accessories: Aluminum; Fasteners: Stainless/ Galvanized Steel; Glazing & Frame Sealant: Silicone Polymer/Plasticizer, Limestone, Butan-2-One O,O',O''-(Methylsilyldiylidene) Trioxime, N-(3-Trimethoxysilyl)propyl Ethylenediamine, Butan-2-One O,O',O''-(Vinylsilyldiylidene) Trioxime; Urethane Foam: Non-Hazardous Proprietary Blend (0.03%)

LBC Temp Exception (10-E4 Proprietary Ingredients <1%)

Living Building Challenge Criteria:

DUX-0001
VOC Content: N/A
Declaration Status
EXP 01 APR 2018
VOC Emissions: N/A
LBC Red List Free
LBC Compliant
Declared

MAKING OURSELVES RESPONSIBLE FOR LABEL ACCURACY
INTERNATIONAL LIVING FUTURE INSTITUTE™ declareproducts.com



**LIVING
BUILDING
CHALLENGE**