

Material Options

Material Log									
		Material	Name	Low	Medium	High	Warranty	Cost	Units
Structural System	Concrete	Precast Concrete	ss-1			x		\$ 84.95	sf
		Site-Cast Concrete	ss-2	x				\$ 71.65	sf
	Steel	Structural Steel	ss-3		x			\$ 79.20	sf
Window Type	Coated	No coating	gl-1	x			20-30 years	\$ 28.50	sf
		Low-e	gl-2		x		10-15 years	\$ 31.00	sf
		Anti-reflective	gl-3	x			2 years	\$ 32.00	sf
		Insulated	gl-4			x	25 years	\$ 42.50	sf
		Tinge	gl-5		x		5 years	\$ 31.00	sf
Window Frame Type	Aluminum	Without Thermal Break	wf-1	x			20+ years	\$ 35.00	sf
		With Thermal Break	wf-2		x		20+ years	\$ 50.00	sf
		Stainless Steel	wf-3			x		\$ 65.00	sf
Roofing Types	Flat Roofs	EPDM	rf-1		x		20+ years	\$ 2.35	sf
		TPO	rf-2			x	20 years	\$ 2.80	sf
		Built-up membrane	rf-3		x		15-30 years	\$ 4.00	sf
		Modified bitumen	rf-4		x		15-20 years	\$ 3.69	sf
		Spray Polyurethane Foam	rf-5	x			50 years	\$ 2.50	sf
Paving	Concrete	Concrete	pv-1	x			20-60 years	\$ 4.00	sf
		Concrete (colored)	pv-2		x		20-60 years	\$ 5.00	sf
		Concrete (colored & textured)	pv-3			x	20-60 years	\$ 7.00	sf
		Brick	pv-4		x		25+ years	\$ 5.35	sf
		TRUEGRID Gravel	pv-5			x	25-60 years	\$ 6.00	sf
Retaining Walls		CORTEN steel	rw-1			x		\$ 2.85	sf
		CMU	rw-2	x				\$ 4.00	sf
		Concrete	rw-3		x			\$ 4.50	sf
		Stone Veneer	rw-4		x			\$ 8.00	sf
		Wood	rw-5			x		\$ 15.00	sf
		Gabion	rw-6			x		\$ 12.00	sf
		Brick	rw-7	x				\$ 2.88	sf
Soffit	Wood	Linear Wood	s-1	x				\$ 21.00	sf
		Perf Wood	s-2		x			\$ 30.00	sf
		Wood Grille	s-3	x				\$ 25.00	sf
		Wood Monolithic Cube	s-4			x		\$ 45.00	sf
	Aluminum	Aluminum	s-5	x				\$ 18.00	sf
PolyCarbonate Sheets	Solid Sheets	Solid Sheets	pc-1	x			10+ years	\$ 18.00	sf
	Translucent Sheets	Translucent Sheets	pc-2		x		10+ years	\$ 20.00	sf
	Corrugated Sheets	Corrugated Sheets	pc-3			x	10+ years	\$ 21.00	sf



Material Options: Glazing



Used in Project:

Name:	Solargray, 3/8"
Supplier:	Vitro Glazing
Cost/Square Foot:	\$39
Total Square Footage:	3200 sq.ft.
Total Cost:	\$124,800



Low Cost:

Name:	Starphire, 3/8" Thick
Supplier:	Vitro Glazing
Cost/Square Foot:	\$28.50
Total Square Footage:	3200 sq.ft.
Total Cost:	\$91,200



High Cost:

Name:	Solarcool Solargray Insulated
Supplier:	Vitro Glazing
Cost/Square Foot:	\$42.50
Total Square Footage:	3200 sq.ft.
Total Cost:	\$136,000



Material Options: Glazing

Product Data Sheet

Vitro Monolithic Glass Comparisons

Table of Performance Values ¹									
Glass Thickness		Visible Light Transmittance (VLT) ²	Visible Light Reflectance ²		(Btu/hr ² ft ² °F) NFRC U-Value ³		Solar Heat Gain Coefficient (SHGC) ⁴	Light to Solar Gain (LSG) ⁵	
Inches	mm		Exterior %	Interior %	Winter Nighttime	Winter Argon			
Uncoated									
Clear Glass									
	1/8	3	90	9	9	1.04	na	0.86	1.05
	5/32	4	90	9	9	1.04	na	0.84	1.07
	3/16	5	89	9	9	1.03	na	0.83	1.07
	1/4	6	89	8	9	1.02	na	0.82	1.09
	5/16	8	87	8	9	1.01	na	0.79	1.10
	3/8	10	87	8	8	1.00	na	0.77	1.13
	1/2	12	85	8	8	0.98	na	0.73	1.16
	5/8	16	84	8	8	0.97	na	0.70	1.20
	3/4	19	83	8	8	0.95	na	0.67	1.24
Starphire® Glass									
	1/8	3	91	8	8	1.04	na	0.91	1.00
	5/32	4	91	8	8	1.04	na	0.91	1.00
	3/16	5	91	8	8	1.03	na	0.90	1.01
	1/4	6	91	8	8	1.02	na	0.90	1.01
	5/16	8	91	8	8	1.01	na	0.89	1.02
	3/8	10	91	8	8	1.00	na	0.89	1.02
	1/2	12	90	8	8	0.98	na	0.88	1.02
	5/8	16	90	8	8	0.97	na	0.87	1.03
	3/4	19	90	8	8	0.95	na	0.86	1.05
Acuity™ Glass									
	1/4	6	90	8	8	1.02	na	0.87	1.03
Solexia® Glass									
	1/8	3	83	8	8	1.04	na	0.70	1.19
	5/32	4	81	8	8	1.04	na	0.68	1.19
	3/16	5	79	8	8	1.03	na	0.65	1.22
	1/4	6	77	8	8	1.02	na	0.62	1.24
Atlantica® Glass									
	1/4	6	67	7	7	1.02	na	0.53	1.26
Azuria® Glass									
	5/32	4	75	7	7	1.04	na	0.57	1.32
	3/16	5	72	7	7	1.03	na	0.54	1.33
	1/4	6	68	7	7	1.02	na	0.52	1.31
	5/16	8	61	6	6	1.01	na	0.48	1.27
	3/8	10	57	6	6	1.00	na	0.46	1.24
Solarblue® Glass									
	1/4	6	56	6	6	1.02	na	0.61	0.92
Pacifica® Glass									
	1/4	6	42	5	5	1.02	na	0.49	0.86
Solarbronze® Glass									
	1/8	3	67	7	7	1.04	na	0.73	0.92
	5/32	4	63	7	7	1.04	na	0.70	0.90
	3/16	5	58	6	6	1.03	na	0.67	0.87
	1/4	6	53	6	6	1.02	na	0.63	0.84
	5/16	8	43	6	6	1.01	na	0.57	0.75
	3/8	10	37	5	6	1.00	na	0.53	0.70
	1/2	12	27	5	5	0.98	na	0.47	0.57
Optigray® Glass									
	1/4	6	63	6	6	1.02	na	0.64	0.98
Solargray® Glass									
	1/8	3	60	6	7	1.04	na	0.69	0.87
	5/32	4	56	6	7	1.04	na	0.66	0.85
	3/16	5	50	6	6	1.03	na	0.62	0.81
	1/4	6	44	6	6	1.02	na	0.58	0.76
	5/16	8	33	5	6	1.01	na	0.51	0.65
	3/8	10	28	5	5	1.00	na	0.48	0.58
	1/2	12	18	5	5	0.98	na	0.42	0.43

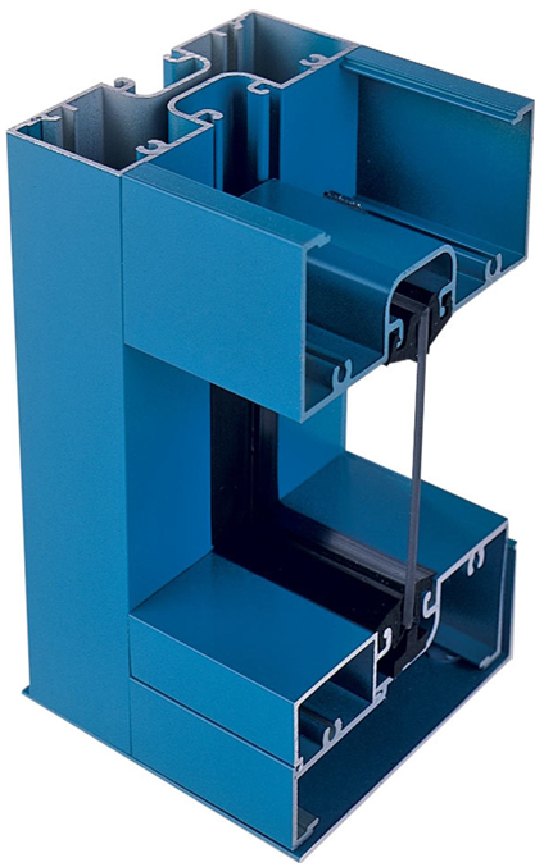


Material Options: Glazing

Table of Performance Values*1									
Glass Thickness		Visible Light Transmittance (VLT) ²	Visible Light Reflectance ²		(Btu/hr ² ft ² °F) NFRC U-Value ³		Solar Heat Gain Coefficient (SHGC) ⁴	Light to Solar Gain (LSG) ⁵	
Inches	mm		Exterior %	Interior %	Winter Nighttime	Winter Argon			
Uncoated									
Graylite® II Glass									
1/8	3	24	5	5	1.04	na	0.45	0.53	
5/32	4	18	4	5	1.04	na	0.41	0.44	
3/16	5	13	4	5	1.03	na	0.39	0.33	
1/4	6	9	4	5	1.02	na	0.36	0.25	
Coated									
Vistacool® (2) Azuria® Glass									
1/4	6	52	19	29	1.02	na	0.46	1.13	
Vistacool® (2) Pacifica® Glass									
1/4	6	32	10	28	1.02	na	0.44	0.73	
Solarcool® (2) Azuria® Glass									
3/16	5	27	20	36	1.04	na	0.39	0.69	
1/4	6	26	19	36	1.03	na	0.38	0.68	
Solarcool® (1) Azuria® Glass									
3/16	5	27	36	20	1.03	na	0.32	0.84	
1/4	6	26	36	19	1.03	na	0.31	0.84	
Solarcool® (2) Solarblue® Glass									
1/4	6	21	14	36	1.02	na	0.45	0.47	
Solarcool® (1) Solarblue® Glass									
1/4	6	21	36	14	1.02	na	0.38	0.55	
Solarcool® (2) Pacifica® Glass									
1/4	6	16	10	36	1.02	na	0.38	0.42	
Solarcool® (1) Pacifica® Glass									
1/4	6	16	36	10	1.02	na	0.31	0.52	
Solarcool® (2) Solarbronze® Glass									
1/4	6	21	13	36	1.03	na	0.47	0.45	
Solarcool® (1) Solarbronze® Glass									
1/4	6	21	36	13	1.03	na	0.40	0.53	
Solarcool® (2) Solargray® Glass									
1/4	6	17	11	36	1.03	na	0.44	0.39	
Solarcool® (1) Solargray® Glass									
1/4	6	17	36	11	1.03	na	0.37	0.46	

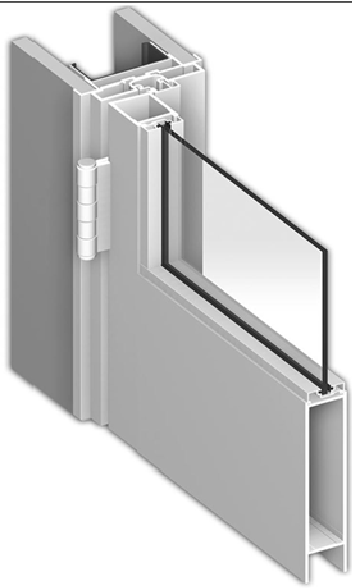


Material Options: Storefront System



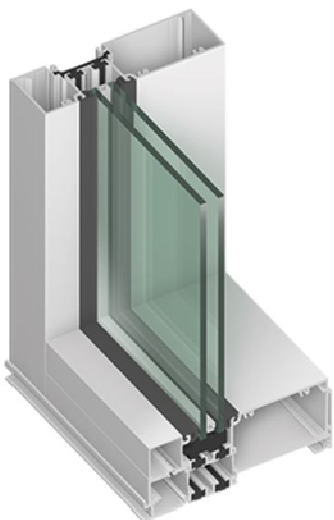
Used in Project:

Name:	4500 Series - Black
Supplier:	Tubelite
Cost/Square Foot:	\$36
Total Square Footage:	3200
Total Cost:	\$115,200



Low Cost:

Name:	INT45 - Black Finish
Supplier:	Tubelite
Cost/Square Foot:	\$28
Total Square Footage:	3200
Total Cost:	\$89,600

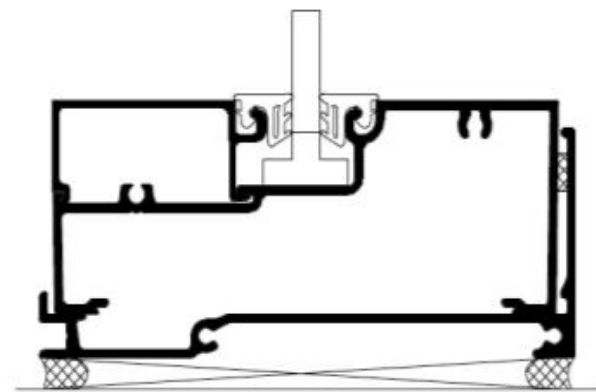
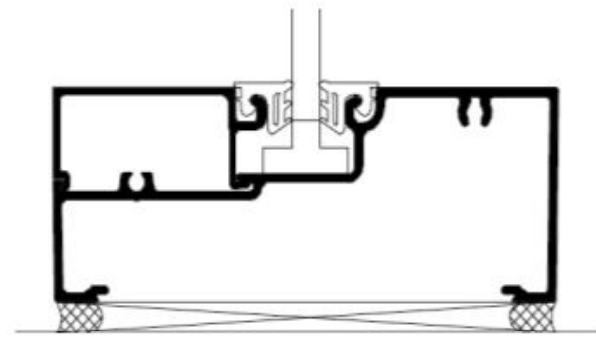
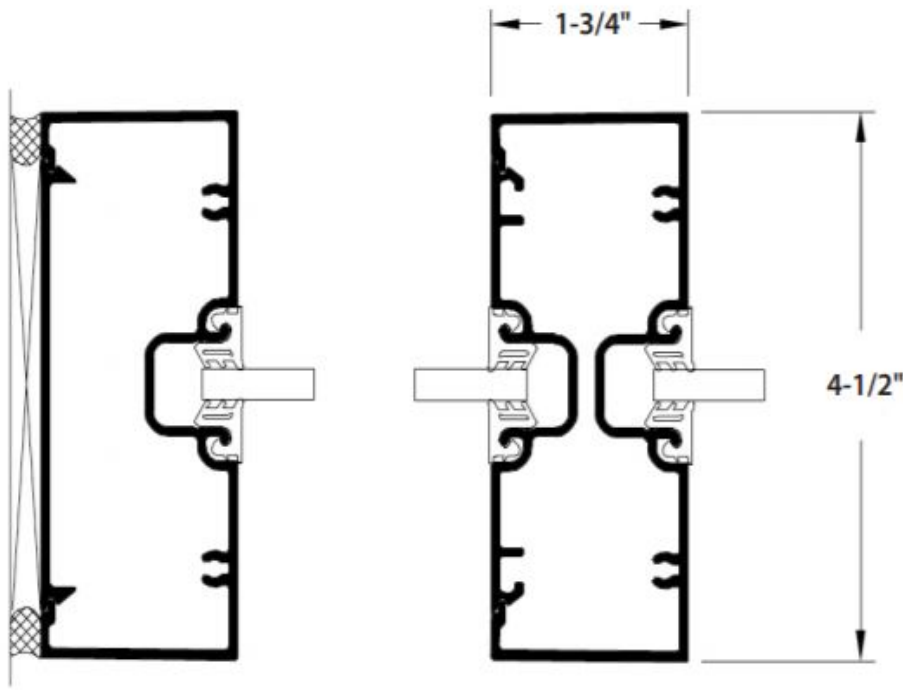


High Cost:

Name:	Thermal Block TU24650
Supplier:	Tubelite
Cost/Square Foot:	\$50
Total Square Footage:	3200
Total Cost:	\$160,000

Material Options: Storefront

4500 Series Storefront Framing



System Features:

- Standard 1 3/4" (44.5mm) sight-line on verticals and horizontals
- 4-1/2" (114.3mm) system depth
- EPDM wedge type gaskets for 1" glass or panel thickness
- Glass centered in the system depth

Optional Features:

- Screw-spline or shear block connections
- Steel reinforcing if required
- Easily integrates with standard doors & operable vent windows
- A wide variety of standard anodized and painted colors are available to complement any project with warranted protection, as well as street appeal.

4500 Series Product Specifications

Application: Low and mid-rise commercial buildings including retail, office, healthcare, schools, etc.

Description: 1-3/4" x 4-1/2" center set, screw spline or shear block construction non thermal storefront field glazed, shear block construction storefront.

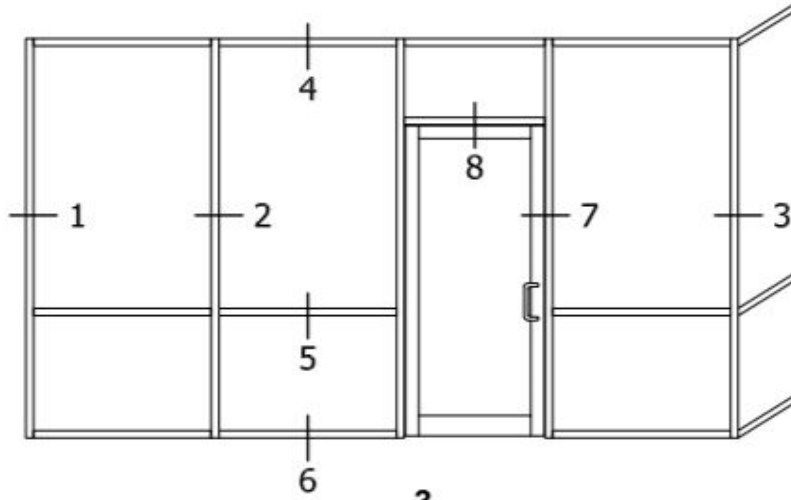
Face Width:	Overall Depths:	Glass:	Air Infiltration:	Water Infiltration:	Structural:	Acoustic:
1-3/4"	4-1/2"	1/4" std. (3/16" to 3/8")	0.06 CFM/Ft.2 @ 6.24 PSF	12 PSF - Static 12 PSF - Dynamic	30 PSF - Design 45 PSF - Overload	28 STC 27 OITC

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Material Options: Storefront

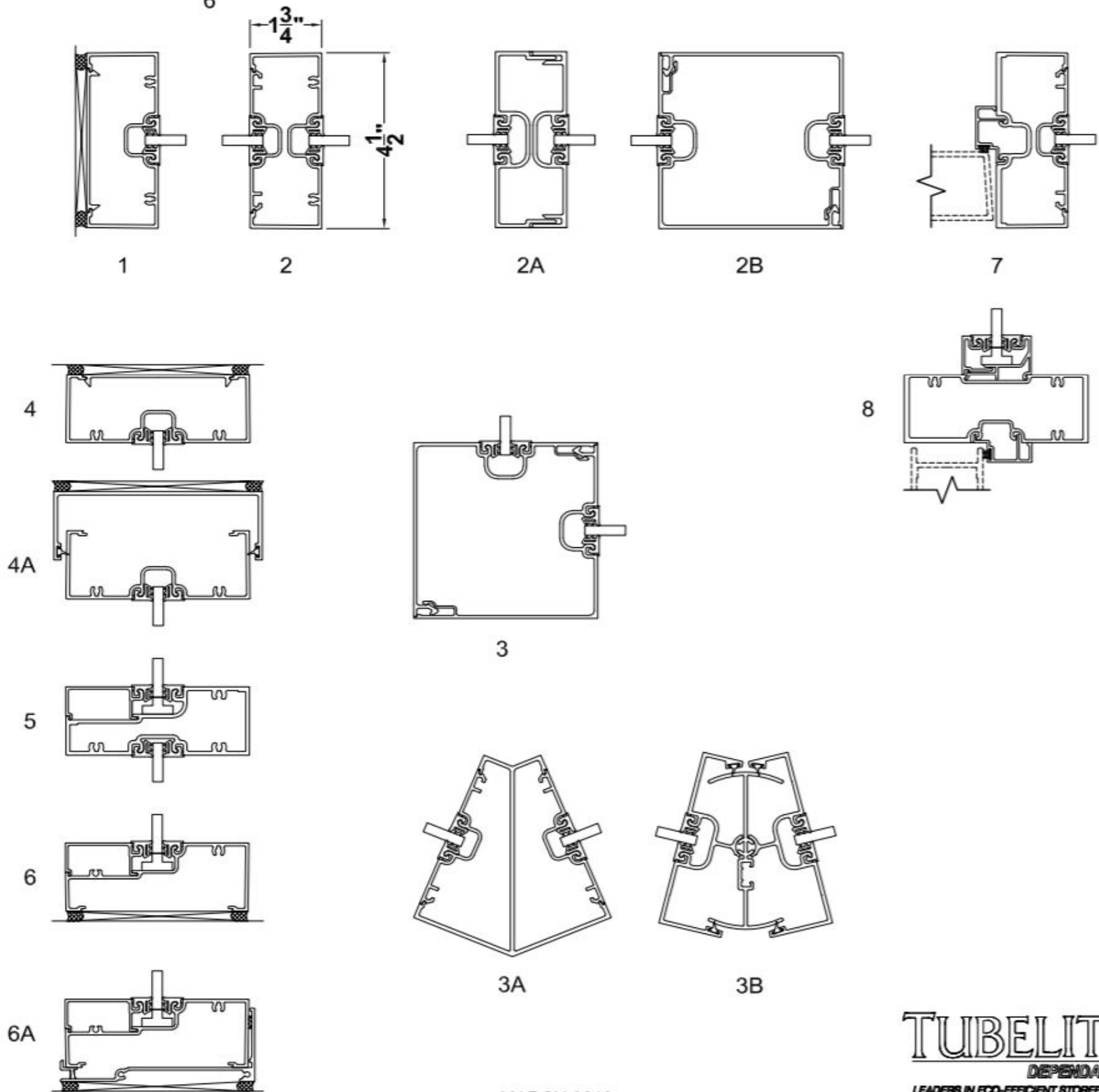
4500 STOREFRONT



Tubelite reserves the right to change system configuration without prior notice when deemed necessary for product improvements.

Laws and building & safety codes governing the design and use of glazed entrance, window and curtain wall systems vary widely. Tubelite does not control the selection of product configurations, operating hardware or glazing materials, and assumes no responsibility thereof.

Standard Details 1/4 scale



MARCH 2019

TUBELITE
DEPENDABLE
LEADERS IN ECO-EFFICIENT STOREFRONT,
CURTAINWALL AND ENTRANCE SYSTEMS

Material Options: Roofing

Used in Project:



Name:	TPO 45 mil.
Supplier:	Mule-Hide
Cost/Square Foot:	\$2.03
Total Square Footage:	1880 sq.ft.
Total Cost:	\$3,816



Medium Cost:

Name:	TPO 60 mil.
Supplier:	Mule-Hide
Cost/Square Foot:	\$2.15
Total Square Footage:	1880 sq.ft.
Total Cost:	\$4,042



High Cost:

Name:	EPDM 60 mil.
Supplier:	Mule-Hide
Cost/Square Foot:	\$4
Total Square Footage:	1880 sq.ft.
Total Cost:	\$7,520

Material Options: Roofing



Product Data Sheet

TPO-c MEMBRANE (Standard, FR and CLEAN Film)

PRODUCT DESCRIPTION

Revision Date: Oct 2020

Mule-Hide TPO-c Membrane is a polyester reinforced, .045" or .060 thick, polyolefin based, thermoplastic, heat-weldable membrane. High breaking strength, tearing strength, and puncture resistance is achieved by encapsulating a strong polyester fabric between the top and bottom plies. Mule-Hide TPO-c FR membrane is formulated with additional flame retardant (compared to Standard) for higher slope fire code approvals. The TPO-c membrane is also available in a 0.80" thickness (see Product Data Sheet for TPO-c EXTRA). The membrane is environmentally friendly and safe to install. All Mule-Hide TPO membranes include MHP Weathering Package, an industry leading, state of the art weather package that enables Mule-Hide TPO membranes to withstand the extreme weatherability testing which simulates exposure to severe climates.



BASIC USES

The TPO-c membrane is used in mechanically attached and fully adhered roofing systems in new construction, reroofing and recover (retrofit) applications. It may also be used as flexible membrane flashings for walls, curbs, etc, when installing TPO-c membrane roofing systems. The system must be installed over acceptable roof insulation or other suitable substrate. See the Mule-Hide TPO Specifications Manual for complete specifications and details.

Optional CLEAN Film

The TPO-c membrane is available with an optional CLEAN Film (Standard colors only), a temporary protective film factory applied to the top surface of the membrane. By protecting the membrane surface from scuffs and dirt accumulation during installation, this protective film can save labor and time by helping to eliminate the need for roof cleaning upon project completion. CLEAN Film can be left in place for up to 90 days. Durable and easy to remove, CLEAN Film helps to improve the aesthetics and long-term reflectivity and is ideal for use on re-roofing, re-cover and new construction projects. CLEAN Film is available on TPO-c 60 mil membranes supplied in 6' x100' and 10' x 100' rolls.

BENEFITS & SUPPLEMENTAL STATEMENTS

- Wide window of weldability
- Outstanding puncture resistance
- Chlorine-free with no halogenated flame retardants
- UL 2218 Class 4 hail rating available on select systems
- Excellent low temperature impact resistance
- Excellent chemical resistance to acids, bases, restaurant oils and greases
- Plasticizer-free, does not contain liquid or polymeric plasticizer
- Exceptional resistance to solar UV, ozone and oxidation
- Low water vapor permeance and water absorption
- Hot melt extrusion processed for complete scrim encapsulation
- Non woven reinforcement fabric for smooth surface and greater thickness-over-scrim
- Polyester reinforcing fabric which is resistant to degradation by bacteria, mildew and fungi
- TPO-c is 100% recyclable
- Meets and exceeds requirements of ASTM D6878 Standard Specification for Thermal Plastic Polyolefin Based Sheet Roofing
- CLEAN Film guards the TPO membrane surface from scuffs and dirt accumulation during installation, helping to improve the roof systems appearance and maintain long-term reflectivity.
- CLEAN Film can be left in place for up to 90 days due to its excellent heat and UV resistance.
- Mule-Hide's tan and white TPO membranes are ENERGY STAR® - qualified and California Title 24 compliant and can contribute toward LEED® (Leadership in Energy and Environmental Design) credits.

Material Options: Roofing

Product Data Sheet

TPO-c Membrane (Standard, FR & CLEAN Film)

SPECIFICATIONS

Standard Colors: White, Gray and Tan

Colorway Colors: Medium Bronze, Patina Green, Rock Brown, Slate Gray & Terra Cotta.

Material: .045-inch (Standard Colors only) and .060-inch (nominal) thick polyester reinforced thermoplastic

Sizes: Standard Colors as 4', 6', 8', 10' and 12' sheet widths by 100'

Colorway Colors as 5' and 10' sheet widths by 100'

Weights: 45 Mil - 0.23 lb/ft² (1.1 kg/m²) typical, 60 Mil - 0.29 lb/ft² (1.4 kg/m²) typical

Physical Properties*	Test Method	Requirement	45-mil	60-mil
Thickness Tolerance on nominal, %	ASTM D-751	+15, -10	±10	±10
Thickness over scrim, in. (mm) (avg. of 3 areas)	ASTM D-6878 Optical Method	0.015 min. (0.380)	0.018 typical (0.457)	0.024 typical (0.610)
Breaking Strength, lbf (kN)	ASTM D-751 (Grab Method)	220 (976 N) minimum	225 (1.0) min. 320 (1.4) typical	250 (1.1) min. 360 (1.6) typical
Elongation at break of fabric, %	ASTM D-751 (Grab Method)	15 minimum	15 minimum 25 typical	15 minimum 25 typical
Tear Strength, lbf (N) 8 by 8 in. specimen	ASTM D-751 (B Tongue Tear)	55 (245) minimum	55 (245) min. 130 (578) typical	55 (245) min. 130 (578) typical
Brittleness point, °F (°C)	ASTM D-2137	-40 (-40) maximum	-40 °F (-40 °C) max. -50 °F (-46 °C) typical	-40 °F (-40 °C) max. -50 °F (-46 °C) typical
Linear Dimensional Change (shrinkage) % change	ASTM D-1204 6 hours @ 158° F (70° C)	±1 maximum	+/-1 max - 0.2 typical	+/-1 max - 0.2 typical
Ozone resistance, 100 pphm, 168 hrs.	ASTM D-1149	PASS	PASS	PASS
Factory seam strength, lbf/in (kN/m)	ASTM D-751	66 (290) min	66 (290) minimum	66 (290) minimum
Field seam strength, lbf/in. (kN/m) Seams tested in peel	ASTM D-1876	No requirement	25 (4.4) min. 50 (8.8) typical	25 (4.4) min. 60 (10.5) typical
Water vapor permeance, Perms	ASTM E-96 proc. B	No requirement	0.10 max. 0.05 typical	0.10 max. 0.05 typical
Water Absorption Resistance, mass % Top surface only	ASTM D-471 @ 158°F, 166 hours	No requirement	3.0 max. 0.90 typical	3.0 max. 0.90 typical
Puncture resistance, lbf (N)	FTM 101C Method 2031	No requirement	250 (1.1) min. 325 (1.4) typical	300 (1.3) min. 350 (1.6) typical
Properties after heat aging - ASTM D573, 32 weeks at 240°F or 8 weeks at 275 °F No cracking when bent around 3" dia. mandrel Weight change, %	PASS No Cracking ±1.5 max	PASS No Cracking ±1.0 max	PASS No Cracking ±1.0 max	PASS No Cracking ±1.0 max

*Typical properties and characteristics are based on samples tested and are not guaranteed for all samples of this product. This data and information is intended as a guide and does not reflect the specification range for any particular property of this product.

INSTALLATION INSTRUCTIONS

- 1) Approved insulation shall be attached to the roof deck with an approved insulation adhesive or approved fasteners and plates. Install insulation with its largest dimension perpendicular to the direction of the membrane seams where possible.
- 2) Mechanically Attached Roofing System
 - a) Perimeter sheets to be installed in an approved pattern along all exterior roof edges.
 - b) Mechanical fasteners and plates are installed in the seams of both the perimeter sheets and field sheets and into the roof deck. Use approved fasteners and maintain proper penetration for specific roof decks.
- 3) Fully Adhered Roofing System
 - a) Perimeter sheets are not required.
 - b) The membrane is required to be mechanically attached at the base of all vertical surfaces, roof edges, and angle changes.
 - c) The field of the roof is fully adhered to the substrate with Mule-Hide TPO Bonding Adhesive.
- 4) Remove CLEAN Film from areas that are to be heat-welded together. In areas not requiring heat-welding, CLEAN Film can be left in place for up to 90 days. Upon completion of the TPO roofing system, remove the CLEAN film and discard.
- 4) All seams are hot air welded and checked by probing.
- 5) All details will be done in accordance with Mule-Hide details.
- 6) On projects where a Mule-Hide System Warranty is requested, an authorized Mule-Hide representative shall inspect all completed work. This is only a brief summary and not the complete specification. The Mule-Hide Specifications, Details, Technical Bulletins, and associated documents should be thoroughly reviewed prior to starting any project. Contact the Mule-Hide Technical Department for additional information.



Material Options: Roofing

Product Data Sheet

TPO-c Membrane (Standard, FR & CLEAN Film)

PRECAUTIONS

- Maximum sustained temperature not to exceed 160°F (71°C) for TPO membrane.
- Use proper stacking procedures to ensure roll stability. Avoid creasing the membrane.
- Surfaces may be slippery when wet, or due to frost and ice build-up. Exercise caution to prevent falls.
- Mule-Hide TPO membranes are highly reflective to sunlight. Workers should dress appropriately, wear sunscreen, and wear sunglasses that filter out UV light.
- Exercise care when working near roof edge as edges may not be visible when surrounding area is covered with snow.
- Store Mule-Hide membrane in original wrappings in a cool, shaded area. Cover with light-colored, breathable, waterproof tarpaulins. Mule-Hide membrane that has been exposed to the weather must be prepared with Weathered Membrane Cleaner prior to hot air welding.
- Use proper stacking procedures to ensure sufficient stability of the rolls.
- Take care not to stand or place heavy objects on the edge of folded-over membrane, as this could cause a hard crease in the membrane.
- Do not use razor blades or other sharp tools to cut the CLEAN Film while it is still adhered to the TPO membrane as damage to the underlying membrane may occur. Pull the protective film away from the membrane prior to cutting.
- Remove CLEAN Film by pulling towards the center of the roof. Do not remove the film by pulling towards the roof edge.
- A static electricity charge may develop when removing the CLEAN Film from the surface of the membrane sheet. To avoid the possibility of ignition, lids must be closed on any flammable products and fire extinguishers should be readily available.
- Color membranes will 'fade' over time mainly due to the ultraviolet portion of sunlight. Since most roof surfaces are exposed to variable sunlight, some areas will be more susceptible to color changes caused by UV fading. Warranties for color membranes do not cover fading of colors.

EXTREME TESTING FOR SEVERE CLIMATES

ASTM Standard D6878 is the material specification for Thermoplastic Polyolefin-Based Sheet Roofing. It covers material property requirements for TPO roof sheeting and includes initial and aged properties after heat and xenon-arc exposure. As stated in the standard, "the tests and property limits used to characterize the sheet are values intended to ensure minimum quality for the intended purpose." Mule-Hide's goal is to provide TPO that delivers maximum performance for the intended purpose of roofing membranes. Maximum performance requires the membrane to far exceed the requirements of ASTM Standard D6878.

Heat Aging accelerates the oxidation rate the roughly doubles for each 18°F (10°C) increase in roof membrane temperature. Oxidation (reaction with oxygen) is one of the primary chemical degradation mechanisms of roofing materials.

HEAT AGING		
Test Method	ASTM Requirement	Typical Results
ASTM Test - 240° F (116° C), No Visible Cracks	32 Weeks**	>128 Weeks
**Heat exposure comparable to 3,120 weeks (60 years) at 185°F for 8 hours per day.		
Test specimen is 2" by 6" piece of 45-mil membrane un-backed, placed in circulating hot-air oven		
Criterion-no visible cracks after bending aged test sample around 3" diameter mandrel.		
Heat Aging accelerates the oxidation rate that roughly doubles for each 10° C (18° F) increase in roof membrane temperature.		
Oxidation (reaction with oxygen) is one of the primary chemical degradation mechanisms of roofing materials.		

Q-Trac testing combines accelerated weathering with real-world conditions using an array of ten mirrors to reflect and concentrate full spectrum sunlight onto membrane test specimens. The Q-Trac device automatically tracks the sun's path from morning to night. Also, it adjusts to compensate for seasonal changes in the sun's altitude. Eight years in Q-Trac testing is equal to 40 years of real-world exposure. Mule-Hide requires its TPO membranes to pass the equivalent of 40 year exposure in the Q-Trac.

Q-Trac Testing		
Test Method	ASTM Requirement	Mule-Hide Requirement
ASTM Test N/A	N/A	Equivalent of 40 years exposure
Environmental Cycling subjects the membrane to repeated cycles of heat aging, hot-water immersion and xenon-arc exposure.		
Test specimen is 2.75" by 5.5" piece of membrane with edges sealed.		
- 10 days heat aging at 240° F (116° C) followed by		
- 5 days water immersion at 158° F (70° C) followed by		
- 5,040 kJ/m ² (2000 hours at 0.70 W/m ² irradiance) xenon-arc exposure		
Criterion – after 3 completed cycles, test specimens shall remain flexible and not have any cracking under 10x magnifications while wrapped around a 3" diameter mandrel.		



Material Options: Roofing

Product Data Sheet

TPO-c Membrane (Standard, FR & CLEAN Film)

SUPPLEMENTAL APPROVALS, STATEMENTS AND CHARACTERISTICS

- 1) TPO-c meets and exceeds the requirements of **ASTM D6878** Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing.
- 2) Radiative Properties for ENERGY STAR, Cool Roof Rating Council (CRRC) and LEED.
- 3) Mule-Hide TPO-c membranes conform to requirements of the U.S.E.P.A. Toxic Leachate Test (40 CFR part 136) performed by an independent analytical laboratory.
- 4) TPO-c was tested for dynamic puncture resistance per ASTM D5635-04 using the most recently modified impact head. 45-mil was watertight after an impact energy of 12.5 J (9.2 ft-lbf) and 60-mil was watertight after an impact energy of 22.5 J (16.6 ft-lbf)
- 5) NSF-P151 Certification for rainwater catchment systems components. (Plant 91/White Only)

RADIATIVE PROPERTIES for ENERGY STAR*, CRRC and LEED				
DESCRIPTION	TEST METHOD	WHITE TPO-c	TAN TPO-c	GRAY TPO-c
ENERGY STAR® initial solar reflectance	Solar Spectrum Reflectometer	0.79	0.71	N/A
ENERGY STAR® initial solar reflectance after 3 years (un-cleaned)		0.70	0.64	N/A
CRRC initial solar reflectance	ASTM C1549	0.79	0.71	0.46
CRRC solar reflectance after 3 years	ASTM C1549 (un-cleaned)	0.70	0.64	0.43
CRRC initial thermal emittance	ASTM C1371	0.90	0.86	0.89
CRRC thermal emittance after 3 years	ASTM C1371 (un-cleaned)	0.86	0.87	0.88
CRRC SRI (Solar Reflectance Index)	ASTM E1980	99	86	53
CRRC SRI (Solar Reflectance Index after 3 yrs)	ASTM E1980	85	77	48

RADIATIVE PROPERTIES (Initial) FOR COLORWAY COLORS			
Color	Reflectance	Emittance	SRI
Medium Bronze	0.28	0.86	29
Rock Brown	0.25	0.87	26
Slate Gray	0.38	0.87	42
Terra Cotta	0.25	0.86	25
Patina Green	0.25	0.88	25

Solar Reflectance Index (SRI) is calculated per ASTM E 1980. The SRI is a measure of the roof's ability to reject solar heat, as shown by a small temperature rise. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100. Materials with the highest SRI values are the coolest choices for roofing. Due to the way SRI is defined, particularly hot materials can even take slightly negative values, and particularly cool materials can even exceed 100.

*ENERGY STAR® recommends that using the Roof Savings Calculator (rsn.ornl.gov), which factors in both heating and cooling costs, to determine whether a cool roof will be an energy efficient choice for your geographical climate and building type.

LEED Information	
Pre-consumer Recycled Content	10%
Post-consumer Recycled Content	0%
Manufacturing Location	Senatobia, MS Tooele, UT Carlisle, PA
Solar Reflectance Index (SRI)	99 (white) 86 (tan)

PROTECTION & SAFETY

Mule-Hide maintains Safety Data Sheets on all of its non-exempt products. Safety Data Sheets contain health and safety information for your development of appropriate product handling procedures to protect your employees and customers. Mule-Hide's Safety Data Sheets should be read and understood by all of your supervisory personnel and employees before using Mule-Hide products in your facilities.



Material Options: Roofing

Product Data Sheet

TPO-c Membrane (Standard, FR & CLEAN Film)

ADDITIONAL INFORMATION

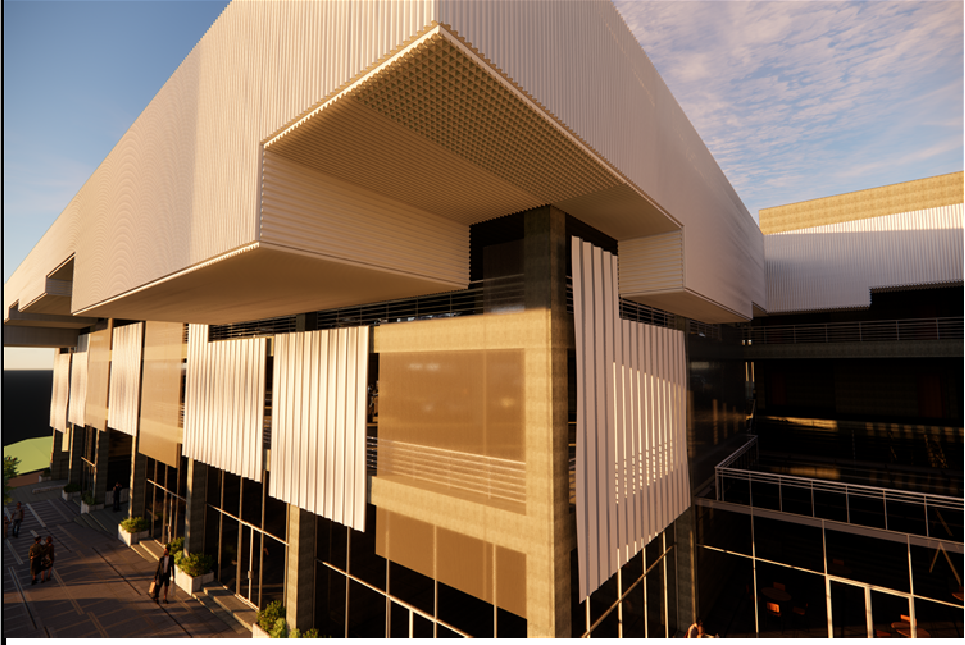
The information given on this PDS is subject to change without notice. Always check the Mule-Hide website at www.mulehide.com for the latest information, changes and updates or contact Mule-Hide Products Company at 800-786-1492.

DISCLAIMER

The statements provided concerning the material shown are intended as a guide for material usage and are believed to be true and accurate at the time of printing. No statement made by anyone may supersede this information, except when done in writing by Mule-Hide Products Co., Inc. Since the manner of use is beyond our control, Mule-Hide does not authorize anyone to make any warranty of merchantability or fitness for any particular purpose or any other warranty, guarantee or representation, expressed or implied, concerning this material. This product may be eligible for a Mule-Hide warranty, please check the Mule-Hide website at www.mulehide.com or contact Mule-Hide directly at 800-786-1492 for details. Buyer and user accept the product under these conditions and assume the risk of any failure, any injury person or property (including that of the user), loss or liability resulting from the handling, storage or use of the product whether or not it is handled, stored or used in accordance with the directions or specifications. Mule-Hide must be notified in writing of any claims and be given the opportunity to inspect the alleged failure before repairs are made.



Material Options: Soffit System



Used in Project:

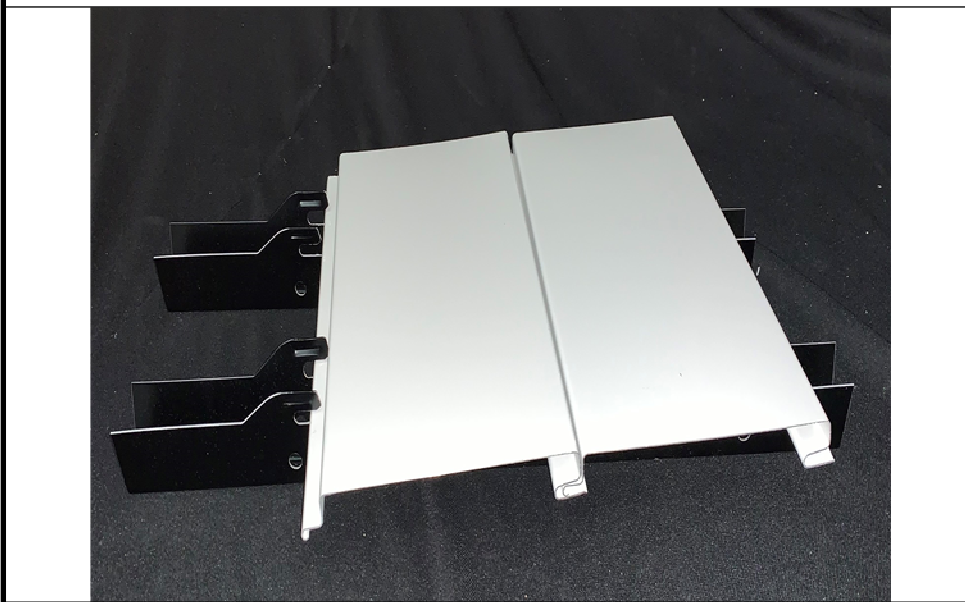
Name:	Precast Concrete
Supplier:	US Formliner
Cost/Square Foot:	\$45.50
Total Square Footage:	5190 sq.ft.
Total Cost:	\$236,145

Low Cost:

Name:	150F Linear Metal
Supplier:	Certainteed
Cost/Square Foot:	\$18
Total Square Footage:	5190 sq.ft
Total Cost:	\$93,420

Medium Cost:

Name:	Wood Grille
Supplier:	9Wood
Cost/Square Foot:	\$45
Total Square Footage:	5190 sq.ft.
Total Cost:	\$233,550



Material Options: Natural Light Inlet



Used in Project:

Name:	Channel Glass
Supplier:	Bendheim
Cost/Square Foot:	\$60
Total Square Footage:	2956 sq.ft.
Total Cost:	\$177,360



Low Cost:

Name:	Polycarbonate - Acrylic
Supplier:	Plazit Polygal
Cost/Square Foot:	\$17.10
Total Square Footage:	2956 sq.ft
Total Cost:	\$50,547

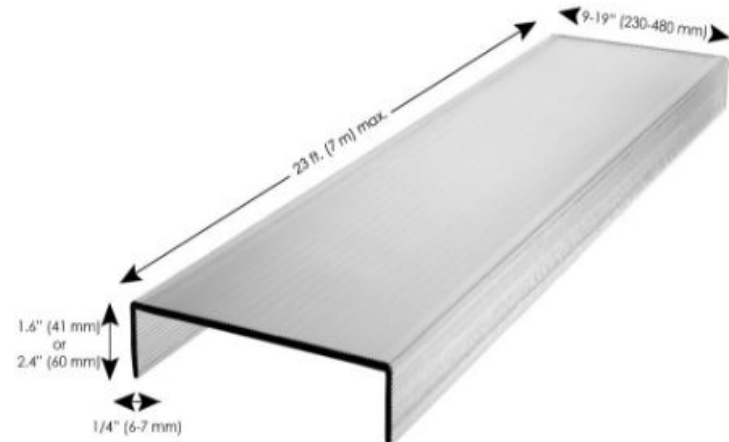


Medium Cost:

Name:	Polycarbonate - Monogal
Supplier:	Plazit Polygal
Cost/Square Foot:	\$23.50
Total Square Footage:	2956 sq.ft
Total Cost:	\$69,466

Material Options: Natural Light Inlet

Low-E Thermal Performance Coating for Channel Glass



Application:

Interior, Exterior

Composition:

Glass: 40% post-consumer + 20% pre-consumer recycled glass with a thermal performance hard coating

Installation:

Approx. 1/4"-thick lightweight glass in channel form is relatively easy to install, especially with the smart design of Bendheim's channel glass wall systems. No specialized training is required. Any competent commercial glazier with curtainwall or storefront installation experience can handle the channel glass installation. Cranes are not required, as individual glass channels are lightweight. The channels can be glazed on site or pre-assembled at the glazier's shop using Bendheim's unique unitized channel glass systems.

Approx Dimensions:

Length = up to 23 ft. (7 m); glass is fabricated to specified length. Width = 9" (230 mm), 10.3" (260 mm), 13" (330 mm), or 19.5" (480 mm). Flange depth = 1.6" (41 mm) for interior use, 2.4" (60 mm) for exterior use. Thickness = 0.24" (6 mm) for interior use, 0.28" (7 mm) for exterior use. Maximum size depends on wind loads, glass safety option, and other factors. Custom sizes may be available, please inquire.

Approx Weight:

Ranges approx. 4-5 lbs/ft² (20-25 kg/m²) for a single layer of channel glass (single-glazed configuration)

Material Options: Natural Light Inlet

Safety Options:

Tempered

Maintenance:

Bendheim glass is easy to maintain. We suggest cleaning with warm water and a lint free cloth (terry cloth). Conventional non-abrasive glass cleaners may also be used.

Performance Characteristics:

STC Rating = STC 34 to STC 38 | Note: STC 34 is based on test of Bendheim I-41 conventional interlocking double-glazed channel glass wall system with push-in gaskets. Wet-sealed I-60 channel glass system is projected to reach STC 38. Compare to STC 33 for a typical interior wall (1/2" drywall on each side, wood studs, no insulation) and STC 39 for a typical insulated interior wall (1/2" drywall on each side, wood studs + fiberglass insulation)

Testing:

Bendheim tempered safety channel glass is 100% heat soak tested (test is recommended for all exterior tempered glass applications), and Safety Glazing Council certified. It meets the requirements for ANSI Z97.1 & the Consumer Product Safety Commission CPSC 16FR, Part 1201 – Safety Standard for Architectural Glazing Materials. Heat soak testing minimizes the risk of spontaneous tempered glass breakage as a result of nickel sulfide inclusions.

Options & Customizations:

Glass Textures:

- 504 Rough Cast™
- Clarissimo™

Thermal Insulation Interlayers:

- Okapane (acrylic tubes)
- Wacotech TIMax (fiber glass)

