

PLASKOLITE

TUFFAK®
polycarbonate
sheet for high
performance
architectural glazing


Departures


Departures



Alro Plastics

TUFFAK 15 and TUFFAK AR sheet offer long term performance for abrasion and UV resistance...

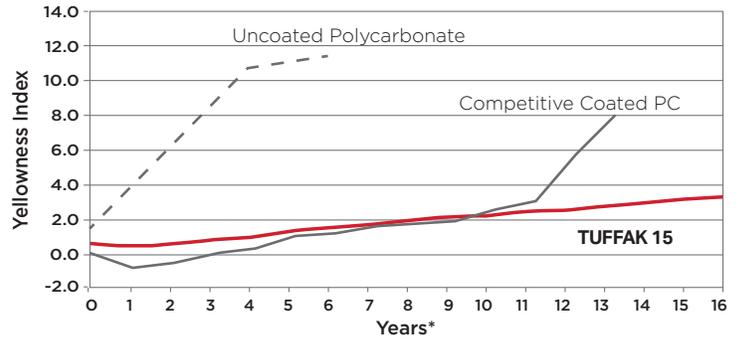
Choose the right TUFFAK sheet for lasting durability and aesthetics in exterior or interior glazing applications

TUFFAK 15 sheet for vertical architectural glazing

- » Up to twice the abrasion and weathering resistance of other polycarbonate glazing
- » 15-year limited product warranty against breakage, yellowing, and loss of light transmission
- » Protects against vandalism, forced entry or attacks
- » Excellent impact resistance
- » Available in a range of standard glazing tints
- » Eliminates bars and wire mesh often required with glass
- » Glazed with standard materials and framing

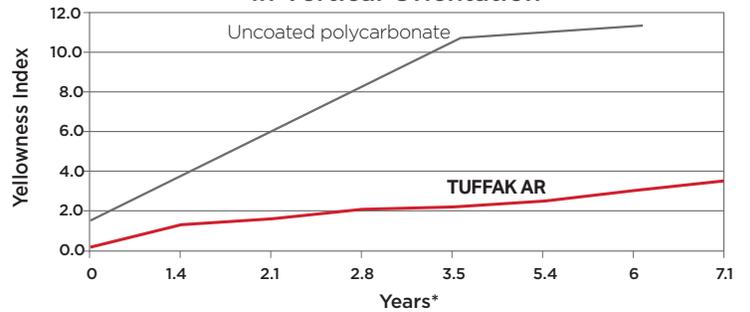


Weathering Behavior of TUFFAK 15 in Vertical Orientation



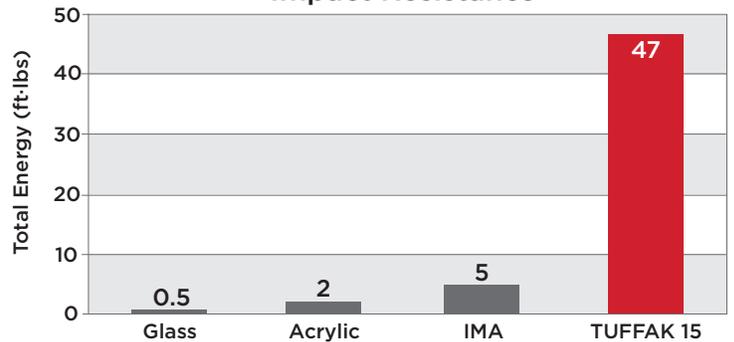
*Based upon Xenon WOM accelerated weathering for UV dose at mid-latitude location

Weathering Behavior of TUFFAK AR in Vertical Orientation



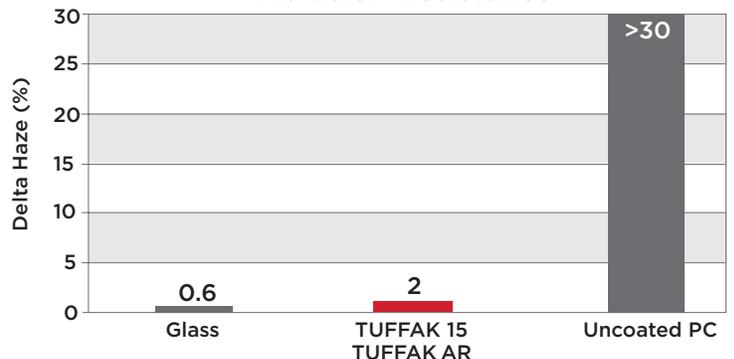
*Based upon Xenon WOM accelerated weathering for UV dose at mid-latitude location

Impact Resistance*



*Instrumented Impact per ASTM D 3763, sample thickness 0.125" nominal

Abrasion Resistance*

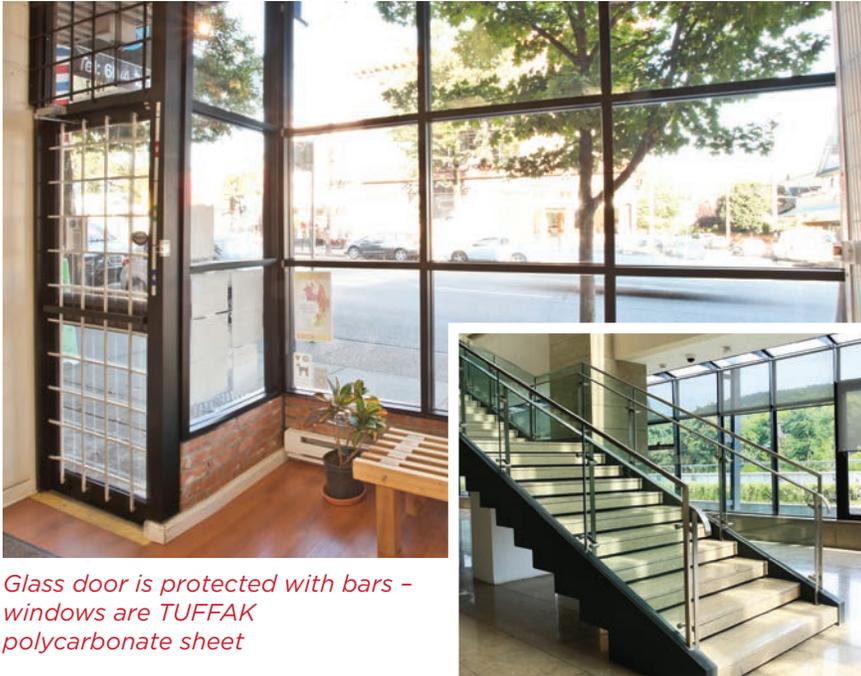


*Taber Abrasion per ASTM D 1044, 100 cycles using CS-10F wheels at 500 g load

High impact strength resists breakage – enhances security

TUFFAK AR abrasion resistant sheet for high traffic interiors

- » Superior toughness for increased security
- » Exceptional level of abrasion and mar resistance to withstand routine abuse and cleaning
- » Easy removal of graffiti from billboard and signage covers
- » Ideal for interior partitions, entry areas, stair railings, and clean rooms



Glass door is protected with bars - windows are TUFFAK polycarbonate sheet

Chemical Resistance*

Chemical Tested	Resistance Time
Acetone	>24 hrs
Ammonia (10% concentration)	>24 hrs
Antifreeze (50/50)	>24 hrs
Benzene	>24 hrs
Bleach (Clorox concentrated)	>24 hrs
Chloroform	>24 hrs
Denatured Alcohol	>24 hrs
Di (2-ethylhexyl) phthalate	>24 hrs
Diesel Oil	>24 hrs
Isopropyl Alcohol (IPA)	>24 hrs
Kerosene	>24 hrs
Methyl Alcohol	>24 hrs
Methyl Butyl Ketone	>24 hrs
Methyl Ethyl Ketone	>24 hrs
Methylene Chloride	>24 hrs
Naphthalene, 1-bromo-	>24 hrs
Potassium Hydroxide - Lye (10%)	>24 hrs
Sodium Hydroxide (10%)	>24 hrs
Toluene	>24 hrs
Turpentine	>24 hrs
Unleaded Gasoline (87 Octane)	>24 hrs
Vinegar	>24 hrs
Xylene	>24 hrs
Acids:	
Hydrochloric Acid (20%)	>24 hrs
Nitric Acid (20%)	>24 hrs
Sulfuric Acid (20%)	>24 hrs

*Tested in accordance to ASTM D 1308-02
Always keep hazardous chemicals away from uncoated edge of TUFFAK polycarbonate

Glazing Materials Comparison

Property	Polycarbonate	Acrylic	Glass
Impact Resistance, Drop Ball Test, 0.5 lb	No Break	1.75 ft·lbs	0.7 ft·lbs
Fabrication on-site	Yes	Yes	No
Sheet Weight, 0.125"	0.78 lb/ft ²	0.75 lb/ft ²	1.60 lbs/ft ²
Thermal Expansion Rate	3.75 x 10 ⁻⁵ in/in/°F	4.10 x 10 ⁻⁵ in/in/°F	5.0 x 10 ⁻⁶ in/in/°F
Shading Coefficient, 0.236" clear sheet	0.97	1.01	1.03
U Factor - Summer, 0.236"	0.85 BTU/hr·ft ² ·°F	0.83 BTU/hr·ft ² ·°F	0.92 BTU/hr·ft ² ·°F
U Factor - Winter, 0.236"	0.92 BTU/hr·ft ² ·°F	0.91 BTU/hr·ft ² ·°F	1.02 BTU/hr·ft ² ·°F

Regulatory code compliance and certifications

ANSI Z97.1-2009, 2015: American National Standard for Safety Glazing Materials Used in Buildings
Safety Performance Specifications and Methods of Test, Class A, Unlimited

CPSC 16 CFR 1201 Category I and Category II: Safety Standard for Architectural Glazing Materials

Florida Building Code 2017, 6th Ed.

High Velocity Hurricane Zone Classified

Miami-Dade NOA: NOA

ICC-ES Evaluation Report ESR-2728

UL 94 Flammability File #E351891

UL 972: Burglary Resistant File #BP2126

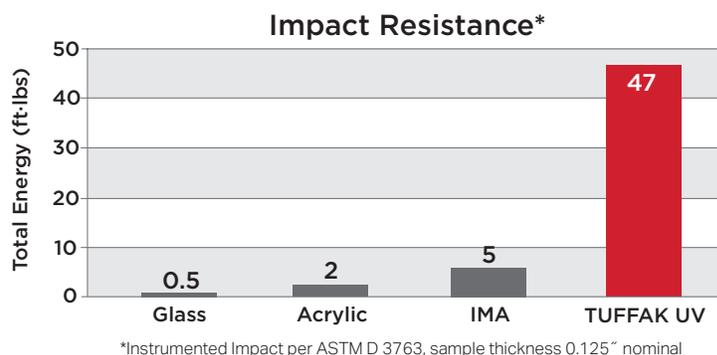
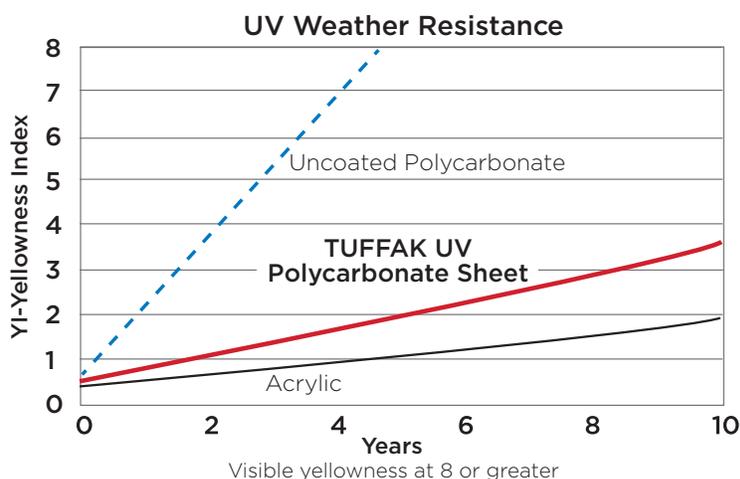
TUFFAK UV sheet for overhead glazing, provides long term UV and impact resistance,

- » Provides lasting protection for entrance canopies, covered pedestrian walkways, shelters, sky lights, and transportation terminals
- » 10-year limited product warranty
- » Cut and cold form on-site for cost effective installation versus preformed glass
- » Cold bend to tight radii versus acrylic for more design versatility
- » HD prismatic and smooth pattern optimized to diffuse and distribute light while maintaining high light transmission and reducing glare
- » Proprietary UV cap for enhanced UV resistance

- » Can be draped and thermoformed for contoured applications
- » Approximately 60 times stronger than acrylic and 15 times stronger than impact modified acrylic
- » Building code compliance (www.plaskolite.com)

Applications

Awnings, skylights, entryway canopies, barrel vaults, glazed archways, covered pedestrian walkways, transom windows, wall panel glazing and sloped, vertical and curved glazing



weatherability and toughness



Regulatory code compliance and certifications

ANSI Z97.1-2009, 2015: American National Standard for Safety Glazing Materials Used in Buildings -
Safety Performance Specifications and Methods of Test, Class A, Unlimited

Florida Building Code 2017, 6th Ed.
High Velocity Hurricane Zone Classified
Miami-Dade NOA: NOA

Hail Impact Resistance (FM 4431) Class 4 Severe Rating - Pass

IBC 2012 Rating for Horizontal Burn Rate ASTM D635-10 - CC1

IBC 2012 Self Ignition Greater than 650°F ASTM D1929-13a - Pass

UL 972: Burglary Resistant File #BP2126

TUFFAK SK family of products



“Daylighting” is the use of “smart skylights” to distribute natural sunlight into a single story building and significantly reduce the need for electrical lighting. In response to a market demand to improve “daylighting”, Covestro has engineered the TUFFAK SK polycarbonate sheet family of products to meet the varied but strict design requirements of “smart skylights”.

These products are designed to support energy efficient buildings (Table 1).

Table 1: TUFFAK SK family

Product	UV-Cap	High Diffusion	Solar Heat Gain Control
TUFFAK SK	-	-	-
TUFFAK SK1	✓	-	-
TUFFAK SK1 HD	✓	✓	-
TUFFAK SK1 CC	✓	-	✓

TUFFAK SK products are available in smooth or prismatic patterns. TUFFAK SK and TUFFAK SK1 are available in clear or white depending on aesthetic and design preferences. TUFFAK SK1 HD is available only in translucent white whereas TUFFAK SK1 CC is available in a transparent, but slightly blue tint.

TUFFAK SK

TUFFAK SK is often used as an inner sheet of a skylight system, protected from UV exposure by an outer cover of TUFFAK SK 1 UV-enhanced sheet (Figure 1).

TUFFAK SK1

TUFFAK SK1 is produced with a UV-resistant cap layer which allows this product to be used in applications directly exposed to sunlight.

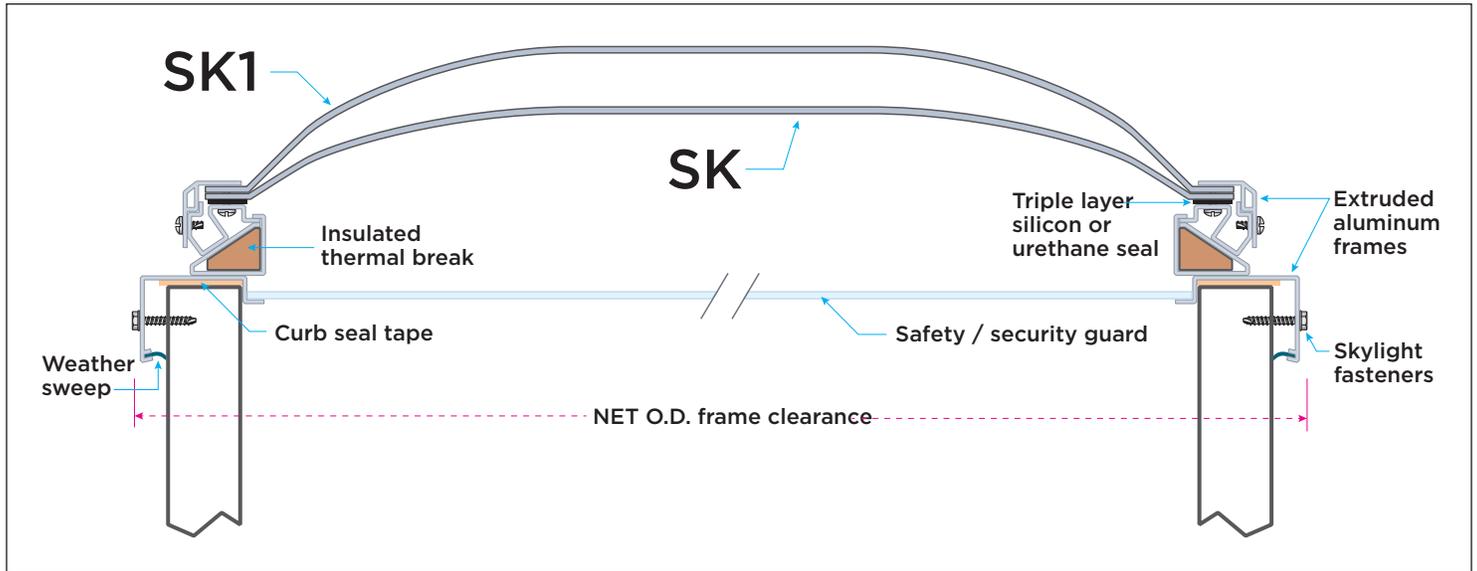
TUFFAK SK1 HD

TUFFAK SK1 HD polycarbonate sheet combines high light transmission and excellent light diffusion characteristics with a weatherable UV cap layer in a single product. Sunlight is uniformly dispersed without annoying hot spots but balanced to maximize light transmission.

TUFFAK SK1 CC

TUFFAK SK1 CC is infrared radiation (IR) absorbing, and thus allows the high transmission of visible light while significantly reducing solar heat gain. Thermal management through solar heat gain control can significantly reduce air conditioning requirements in warm and hot climates.

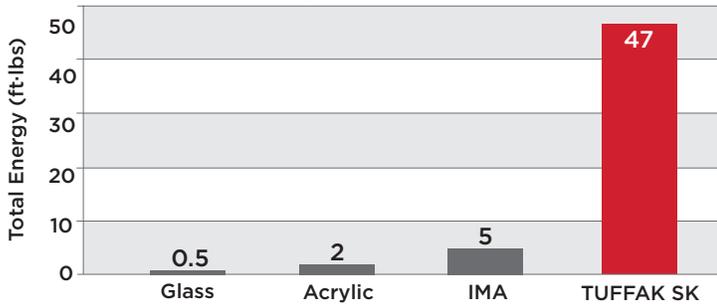
Figure 1: Non-planar skylight



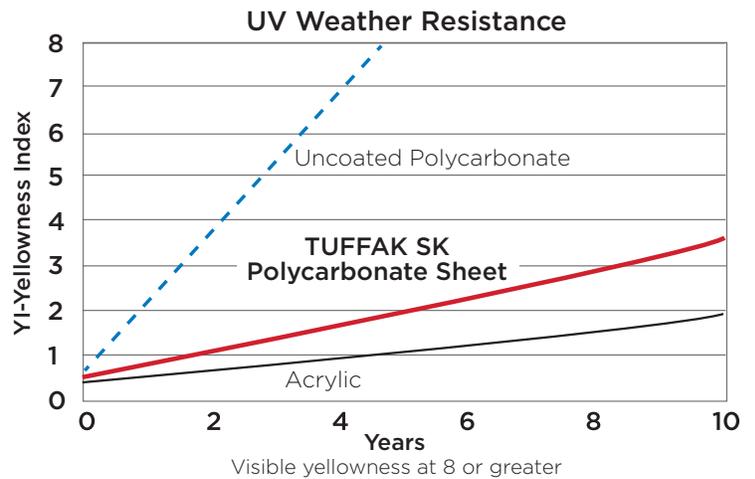
TUFFAK SK Toughness

Skylight toughness is an important roof safety feature to resist skylight breakage from hail and accidental falls by roof workers. When compared to acrylic and glass, TUFFAK SK family of products are much tougher as indicated by impact resistance (Figure 2).

Figure 2: Impact Resistance Comparison
Impact Resistance*



*Instrumented Impact per ASTM D 3763, sample thickness 0.125" nominal
Smooth Surface - No Pattern



Regulatory code compliance and certifications

ANSI Z97.1-2009, 2015: American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test, Class A, Unlimited

Florida Building Code 2017, 6th Ed.

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UL 972: Burglary Resistant File #BP2126

Hygard® CG and Hygard BR withstands extreme threats with no compromises to performance

Hygard CG institutional and correctional facility containment laminates

- » Three levels of protection proven to resist the most rigorous physical attack
- » Meets or exceeds standard containment test agency standards
- » Hard-coat surface technology resists weathering, abrasion, and graffiti



Hygard BR bullet resistant laminate

- » Four levels of protection against multiple threat types
- » Multi-shot resistance against 9 mm submachine gun – UL Level 6 listed
- » Hard-coated surface technology resists weathering, abrasion, and graffiti

Hygard MS 1250 multi-shot protection

- » UL 752 Level 6
- » High speed multi-shot 9 mm (uzi)
- » Hard-coated surface technology resists weathering and abrasion

Security Tests & Product Ratings Overview

Product	Forced Entry Test, Ratings				Ballistics Tests, Ratings		
	Gauge Inches	ASTM F 1233 Class Achieved	ASTM F 1915 Security Grade	HPW TP-0500 Level	HPW TP-0500 Level	UL 752 Level	NIJ 0108 Level
AR	.500	2.0 BP* / 1.4 C*	3	I			
CG 375	.390	2.8 BP / 1.4 C	3	I			
CG 500	.530	3.2 BP / 1.4 C	1	I	A		
CG 750	.780	3.5 BP	1	II	B		
BR 750	.780				B	1	
BR 1000	1.05	5 BP / 2.4 C	1	IV		2	
BR 1250	1.30	5.0 BP / 2.5 C	1	IV		3	II / IIIA
MS 1250	1.30					6	

* BP - Body Passage; C - Contraband

As with any security glazing, performance of HYGARD® products is based on use in appropriate framing systems. For information on glazing system suppliers and full details on performance, test results and agency listings, visit www.plaskolite.com.



TUFFAK AR and Hygard polycarbonate deliver an added layer of intrusion resistant security

Plaskolite's TUFFAK AR glazing addresses today's security challenges. A solution was developed with scalable protection levels to maintain security without compromising appealing architecture and ease of visitor access.



Special Features

- » TUFFAK and Hygard products are approximately 50% lighter than laminated glass of the same thickness and feature a hard coat that resists abrasion, chemical, and graffiti attack
- » Exterior solutions have been tested to meet Florida's High Velocity Hurricane Test Standards

TUFFAK AR and Hygard polycarbonate products are virtually transparent. Unlike glass-clad products, Hygard laminates resist spalling and white-out after repeated high force impacts, leaving a clear line of sight. Security with TUFFAK and Hygard sheets is aesthetically pleasing and tested to ASTM Standards. Rigorous testing ensures the facility doors meet the demands of high-cycle and high abuse environments.

Security ratings for AR 0.500"

Forced Entry & Containment

ASTM F 1233 Class 2.0 Body Passage

ASTM F 1233 Class 1.4 Contraband Passage

ASTM F 1915 Grade 3

H.P. White TP 0500 Level 1 Sequence 8

TUFFAK[®]

Glazing guidelines for Hygard

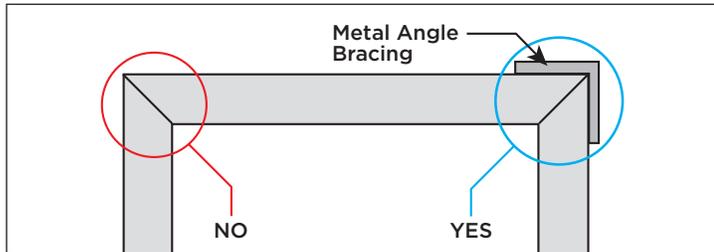
Frame design

Select a metal frame that matches the same level of security-rated protection as the specified Hygard laminate.

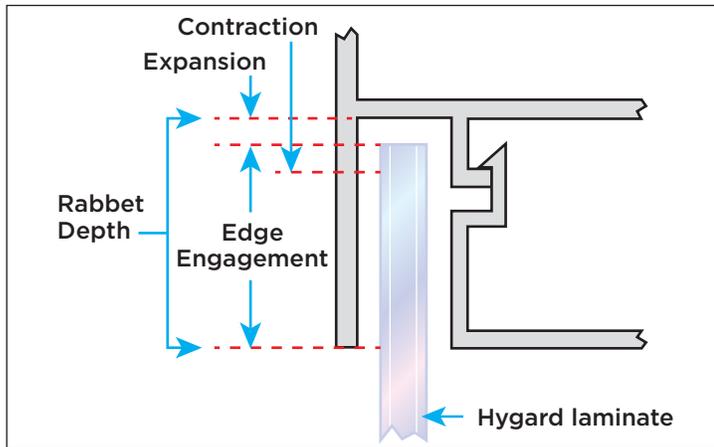
Corner design

Mitered corners require added bracing. Attach metal angle bracing at the corners to strengthen the overall frame.

For optimal frame design, use a continuous metal extrusion.



Product performance relies heavily on the method of attachment, the assembly and the potential for thermal expansion.



Cutting and drilling recommendations

- » Use only sharp cutters
- » Drill holes slightly oversized
- » Drill holes off sheet edge by distance at least 2 times diameter of hole
- » Countersink is not recommended, counter-bore is acceptable in heavy gauge sheet
- » Countersink and counter-bore is not recommended for Hygard laminates
- » As cooling medium use forced air, not cutting fluids
- » Do not allow material to overheat
- » Cut edges must be smooth; sand coarse surfaces and chatter marks
- » Leave masking on product during fabrication, remove soon after installation
- » Use cleaners compatible with polycarbonate. If unsure, consult with manufacturer before use

Glazing recommendations

- » Frame system must meet or exceed Hygard laminate ballistic rating
 - » Hygard laminate dimension must allow for at least 1 inch edge engagement
 - » Use only gaskets, tapes and sealants compatible with polycarbonate
 - » Use setting block strips of polycarbonate, EPDM, neoprene or Santoprene® synthetic rubber
 - » Remove protective masking soon after completing the installation, as prolonged exposure to the outdoors will degrade the film making it difficult or impossible to remove
- Santoprene® is a registered trademark of Exxon Mobil Corporation

TUFFAK and Hygard recommended sealants, gaskets, and tapes

Product Type	Product Name	Manufacturer
Silicone	Dow 795 Dow 999	Dow-Corning Corp • Midland, MI • (800) 346-9882
Silicone	SilPruf Multisil	Momentive Performance Materials • Waterford, NY • (877) 943-7325
Silicone	Spectrem 2 Proglaze SSG	Tremco • Columbus, OH • (800) 321-7906
Gasket	EPDM (60,70D)	Tremco • Columbus, OH • (800) 321-6357
Tape	440 SGT 900	Tremco • Beechwood, OH • (800) 321-7906
Gasket/Tape	Norrne® Foam V-2100 Urethane	Norton Company • Granville, NY • (518) 642-2200
Butyl Tape	SM5601 SM5700	Schnee-Morehead • Irving, TX • (800) 878-7876
Vent Tape	G Series, Top Edge AD 3400 Series, Bottom Edge	ITP • (410) 757-5040

Many other glazing materials are commercially available which are compatible with TUFFAK polycarbonate sheet. Please contact those manufacturers for their recommended products.

Norrne® is a registered trademark of Norton Company

Glazing guidelines for TUFFAK sheet

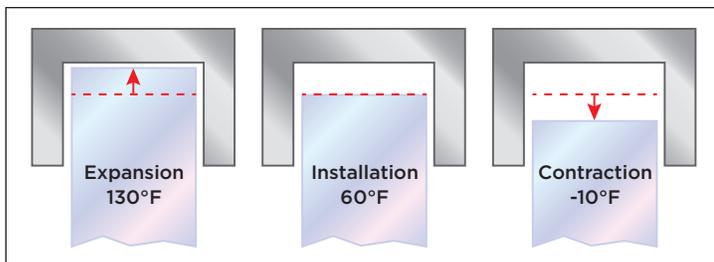
TUFFAK polycarbonate sheet can be installed using wet (caulking type sealant) or dry (gasket type) glazing systems. TUFFAK sheet can be glazed as a single layer, as two layers for added thermal insulation or over-glazed for increased security to an existing window.

General recommendations

- » Match the metal framing (typically aluminum or steel) to the application requirements, such as the wind load or ballistics
- » Engage all sheet edges in the frame
- » Ensure the rabbet depth is sufficient for edge engagement, as well as thermal expansion or contraction
- » Use gaskets, sealants and tapes compatible with polycarbonate that have adequate elongation capability; contact the manufacturer of the product if unsure
- » Note that fastening with bolts through the glazing should only be used when unavoidable; the design needs to be reviewed to ensure thermal movement will not be restricted
- » Note that a sash intended for glass is unlikely to have enough rabbet depth, particularly for windows larger than 36 inches in one dimension
- » Use dry glazing with EPDM or neoprene gaskets for large windows (greater than 24 inches); sealants specifically designed with high elongation may also be a consideration
- » Peel back the masking only around the perimeter of the sheet prior to installation to protect from damage. Remove the remaining masking once the installation is complete. Do not leave the masking on the sheet for an extended period.
- » Use isopropyl alcohol or VM&P naphtha and a soft cloth for cleaning during installation
- » Refer to the TUFFAK sheet cleaning guideline for recommended practices and products

Thermal expansion allowance

The coefficient of linear thermal expansion of TUFFAK sheet is much greater than framing materials, such as aluminum and steel (see table for comparisons). The window design needs to accommodate for adequate expansion room to allow for free movement of the sheet to avoid unsightly sheet bowing and optical distortion. A general guideline is to allow 1/16 inch expansion/contraction per foot of sheet in both the length and width directions.



Comparative expansion rates

Material	Inch/Inch/°F)
TUFFAK	0.0000375
Glass	0.0000050
Aluminum	0.0000129
Steel	0.0000063

Example calculation rabbet depth for a 48-inch sheet length and 70° temperature change

Calculation of Expansion/Contraction

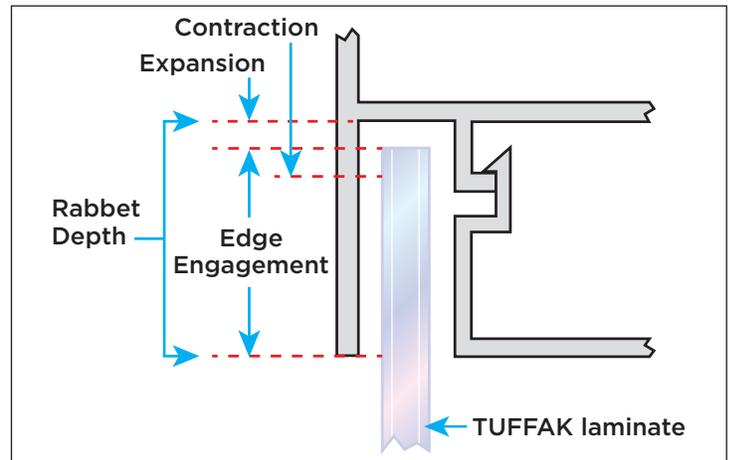
0.0000375 x sheet dimension inches x temperature change

48" expansion: 0.0000375 x 48 x 70 degrees = 0.13"

48" contraction: 0.0000375 x 48 x 70 degrees = 0.13"

Rabbet depth:

$$\text{Edge engagement} + \text{Expansion} + \text{Contraction } 0.56 + 0.26 = 0.82"$$



Sheet edge engagement, thermal expansion and rabbet depth table

Sheet size	24"	36"	48"	60"
Expansion + Contraction	1/8"	3/16"	1/4"	5/16"
+ Edge engagement	3/8"	1/2"	9/16"	3/4"
= Rabbet depth	1/2"	11/16"	13/16"	1-1/16"

Design pressure		Hurricane category	MPH
10 PSF	63 MPH	-	63
20	88	1	74-95
30	108	2	96-110
40	125	3	111-129
50	140	4	130-156

These suggestions and data are based on information we believe to be reliable. They are offered in good faith, but without guarantee, as conditions and methods of use are beyond our control. We recommend that the prospective user determine the suitability of our materials and suggestions before adopting them on a commercial scale.

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