PLASKOLITE

ARCHITECTURAL & CONSTRUCTION

SOLUTIONS GUIDE

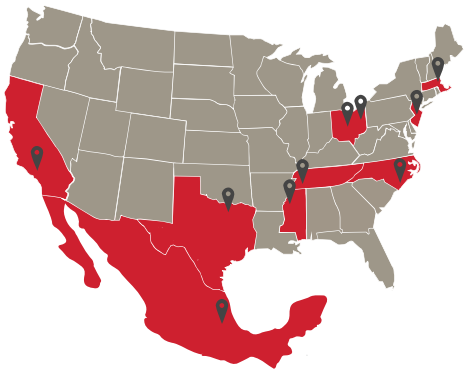
PLASKOLITE

OUR MISSION IS TO DELIVER SUPERIOR ENGINEERED THERMOPLASTIC SHEET TO THE WORLD THROUGH LONG-LASTING CUSTOMER RELATIONSHIPS AND HANDS-ON CUSTOMER SERVICE.

Founded in 1950, PLASKOLITE has built a reputation for providing the highest quality products in the industry. PLASKOLITE is a global manufacturing leader of engineered thermoplastics, which includes Acrylic, Polycarbonate, Multiwall, ABS and PETG Sheet, Lighting Profiles and PMMA Polymers.

MANUFACTURING LOCATIONS

NORTH AMERICA



SOUTH AMERICA

EUROPE

QUICK FACTS

STATUS
Privately Held

GLOBAL HEADQUARTERS
Columbus, OH

EMPLOYEES
1800 worldwide

MARKETS SERVED
Signage, Lighting, Retail Display, Construction, Transportation, Security, Spa & Bath, Industrial, Architecture, & Green Houses

CORE BRANDS

TUFFAK® POLYCARBONATE SHEET

OPTIX® ACRYLIC SHEET

VIVAK® PETG SHEET

POLYGAL®

Lucite SPA

FABBACK® MIRRORED SHEET

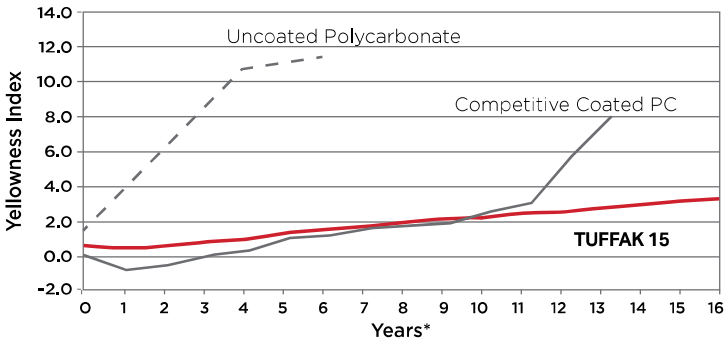
TUFFAK 15 & TUFFAK AR SHEET OFFER LONG-TERM PERFORMANCE FOR ABRASION & UV RESISTANCE

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

TUFFAK 15 sheet for vertical architectural glazing

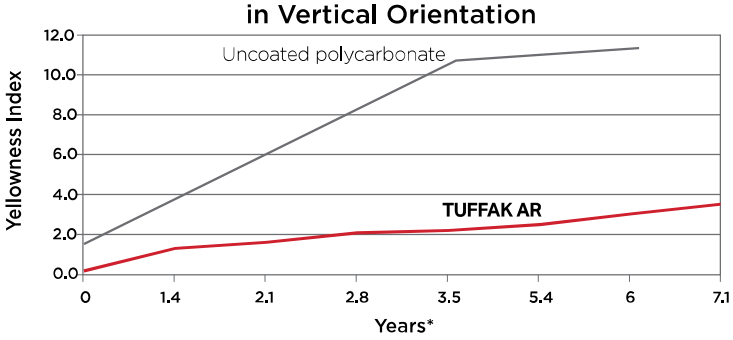
- Up to twice the abrasion and weathering resistance of other polycarbonate glazing
- 15-year limited product warranty against breakage, yellowing, and loss of light transmission
- Protects against vandalism, forced entry or attacks
- Excellent impact resistance
- Eliminates bars and wire mesh often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

Weathering Behavior of TUFFAK 15 in Vertical Orientation



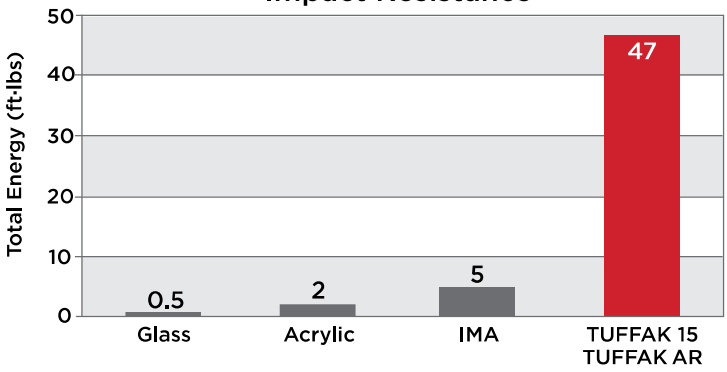
*Based upon Xenon accelerated weathering and a mid-latitude UV exposure

Weathering Behavior of TUFFAK AR in Vertical Orientation



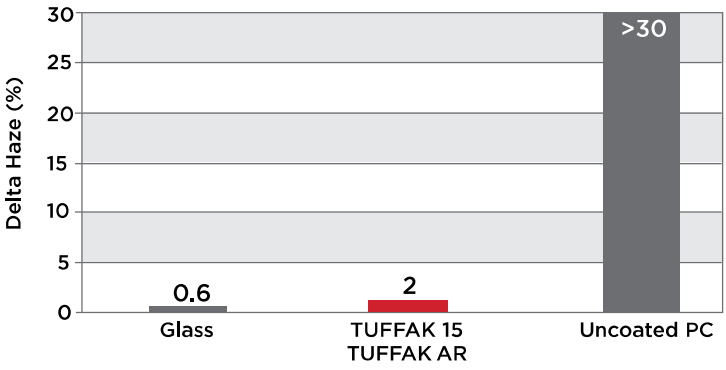
*Based upon Xenon accelerated weathering and a mid-latitude UV exposure

Impact Resistance*



*Instrumented Impact per ASTM D3763, sample thickness 0.125″ nominal

Abrasion Resistance*



*Taber Abrasion per ASTM D1044, 100 cycles using CS-10F wheels at 500 g load

TUFFAK 15 & TUFFAK AR HIGH IMPACT STRENGTH RESISTS BREAKAGE – ENHANCES SECURITY

TUFFAK AR abrasion resistant sheet for high traffic environments

- Superior toughness provides increased security
- Exceptional level of abrasion and mar resistance to withstand repetitive cleanings and high traffic
- Coating allows for easy graffiti removal
- Ideal for window glazing, interior partitions, entry areas, and stair railings, signage and billboard covers

Glass door is protected with bars – windows are **TUFFAK 15** *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 incompatible chemicals away from uncoated edge of TUFFAK polycarbonate. See fabrication guide at Plaskolite.com for details.

Glazing Materials Comparison

Property	Polycarbonate	Glass
Impact Resistance, Drop Ball Test, 0.5 lb	No Break	0.7 ft·lbs
Easy On-site Fabrication	Yes	No
Sheet Weight, 0.125″	0.78 lb/ft^2	1.60 lbs/ft^2
Thermal Expansion Rate	3.75 x 10^{-5} in/in/°F	5.0 x 10^{-6} in/in/°F
Shading Coefficient, 0.236″ clear sheet	0.97	1.03
U Factor – Summer, 0.236″ U Factor – Winter, 0.236″	0.85 BTU/hr/ft^2/°F 0.92 BTU/hr/ft^2/°F	0.92 BTU/hr/ft^2/°F 1.02 BTU/hr/ft^2/°F

Regulatory code compliance and certifications

ANSI Z97.1 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 High Velocity Hurricane Zone Classified Miami-Dade

ICC-ES Evaluation Report #ESR-2728

UL 94 Flammability File #E87887

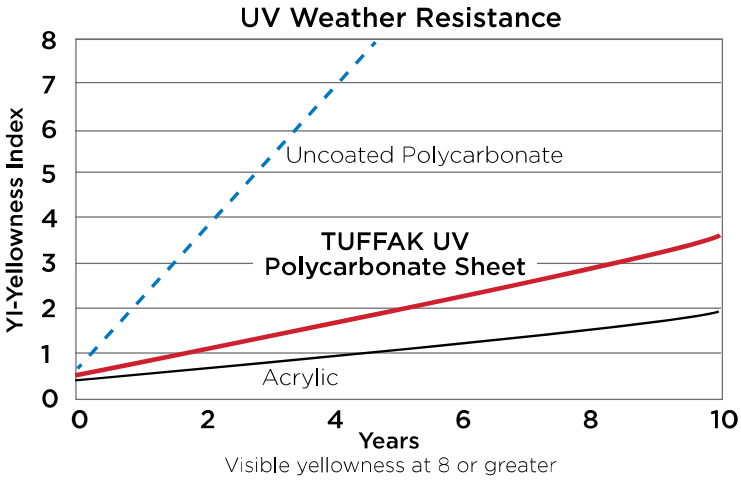
UL 972 Burglary Resistant File #BP2126

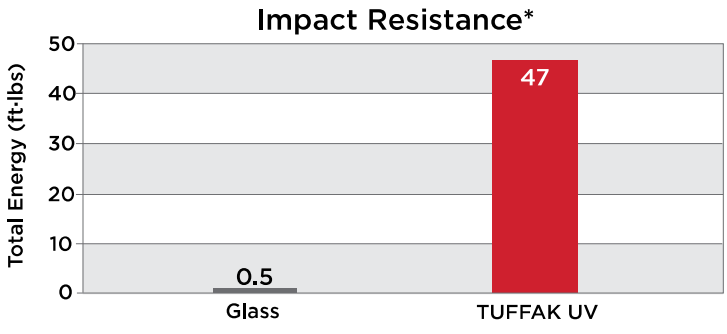
TUFFAK UV SHEET PROVIDES LONG-TERM WEATHERABILITY & IMPACT RESISTANCE FOR OUTDOOR GLAZING

- Proprietary UV resistant cap layer provides lasting protection for outdoor applications
- Can cut and cold bend on-site for design versatility and a cost effective installation versus custom bent glass
- Available in a range of standard glazing tints
- Can be draped and thermoformed for contoured applications
- Approximately 100 times stronger than glass
- Building code compliant per IBC Section 2606.4
- 10-year limited product warranty

Applications

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





*Instrumented Impact per ASTM D3763, sample thickness 0.125˝ nominal

TUFFAK SK
FAMILY OF PRODUCTS

Skylights are often used in daylighting to distribute natural sunlight throughout the interior of a building and significantly reduce the need for electrical lighting. In response to a market demand to improve daylighting efficiency, Plaskolite has engineered the TUFFAK SK polycarbonate sheet family of products to help skylight manufacturers to design highly energy efficient 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	4	–	–
TUFFAK SK1 HD	4	4	–
TUFFAK SK1 CC	4	–	4

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 in high diffusion white and TUFFAK SK1 CC has a light blue transparent 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 SK1 UV-enhanced sheet (Figure 1 on following page).

TUFFAK SK1

TUFFAK SK1 is produced with a UV-resistant cap layer which provides excellent weathering in direct sunlight and it typically used as the outer lite of a two lite skylight (Figure 1).

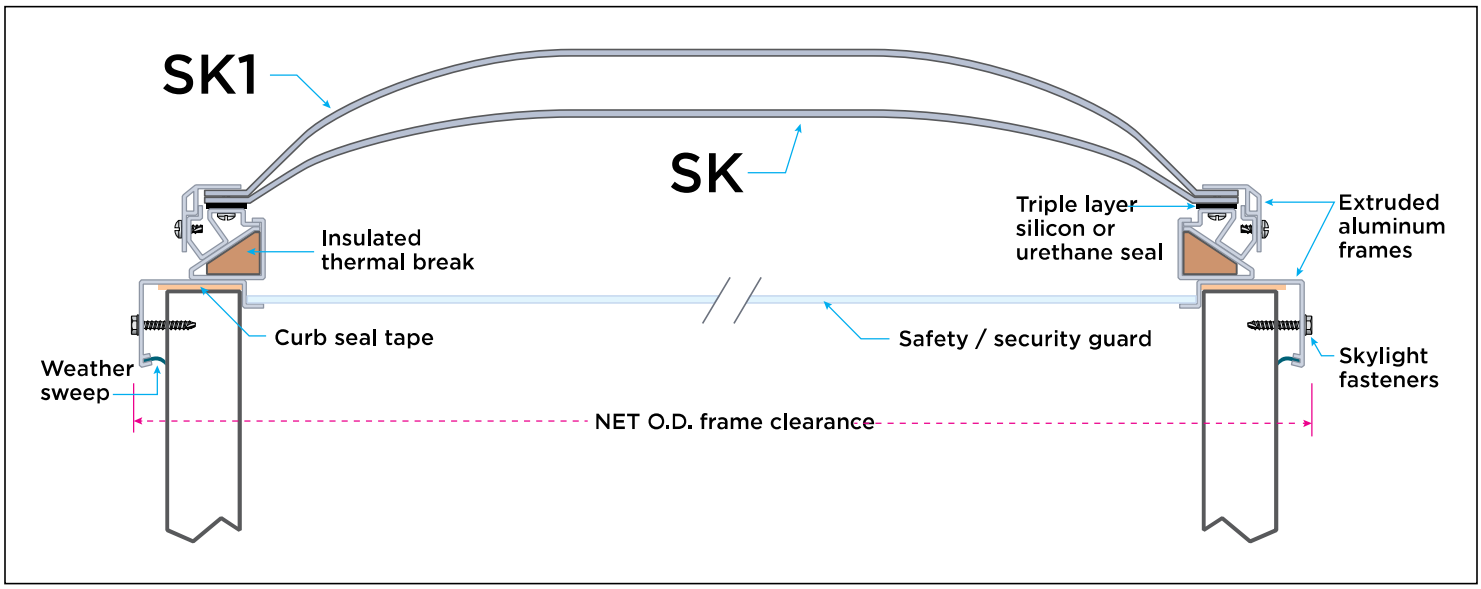
TUFFAK SK1 HD

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 while maintaining high light transmission.

TUFFAK SK1 CC

TUFFAK SK1 CC is an infrared radiation (IR) absorbing sheet that reduces solar heat gain while maintaining high visible light transmission. Thermal management through solar heat gain control can significantly reduce air conditioning requirements in warm and hot climates.

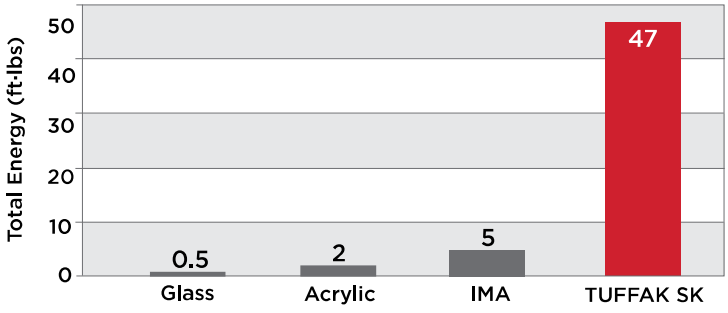
Figure 1: Non-planar skylight



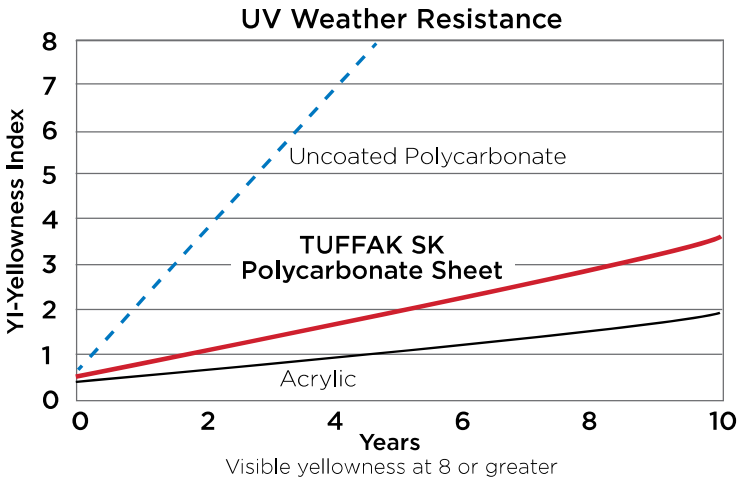
TUFFAK SK Toughness

Skylight toughness is important to resist weather events such as hail or hurricanes and contributes to safety by helping to prevent accidental fall through of maintenance personnel. 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



*Instrumented Impact per ASTM D3763, sample thickness 0.125" nominal Smooth Surface - No Pattern



Visible yellowness at 8 or greater

Regulatory code compliance and certifications

ANSI Z97.1 American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test, Class A, Unlimited
Florida Building Code High Velocity Hurricane Zone Classified Miami-Dade
Hail Impact Resistance (FM 4431) Class 4 Severe Rating – Pass
IBC Rating for Horizontal Burn Rate ASTM D635 – CC1
IBC Self Ignition Greater than 650°F ASTM D1929 – Pass
ICC-ES Evaluation Report #ESR-2728
UL 972 Burglary Resistant File #BP2126
UL 94 Flammability File #E87887

HYGARD® CG & HYGARD BR WITHSTAND EXTREME THREATS WITH NO COMPROMISES

Hygard CG institutional and correctional facility containment laminates

» Three levels of protection proven to resist the most rigorous forced entry, containment, or smash and grab physical attacks

» Meets or exceeds standard containment test agency standards

» Hard-coat surface technology resists weathering, abrasion, and graffiti

Hygard BR bullet resistant laminate

» Three levels of protection against multiple forced entry and ballistic threats

» Hard-coat technology on both sides 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

	Forced Entry Test, Ratings				Ballistics Tests, Ratings		
Product	Gauge Inches	ASTM F1233 Class Achieved	ASTM F1915 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	2.88 BP / 1.5 C	3	I	A		
CG 500	.530	3.2 BP / 1.5 C	1	I	A		
CG 750	.780	3.5 BP / 2.4 C	1	II	B		
BR 750	.780				B	1	
BR 1000	1.05	5.0 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 & HYGARD POLYCARBONATE DELIVER AN ADDED LAYER OF INTRUSION RESISTANT SECURITY

Plaskolite offers TUFFAK AR and Hygard products to meet a range of security protection levels, to address today's security challenges without compromising aesthetics.

Special Features

» TUFFAK and Hygard products are approximately 50% lighter than laminated glass of the same thickness

» Hard coat technology on both sides resists abrasion, chemical, and graffiti attack

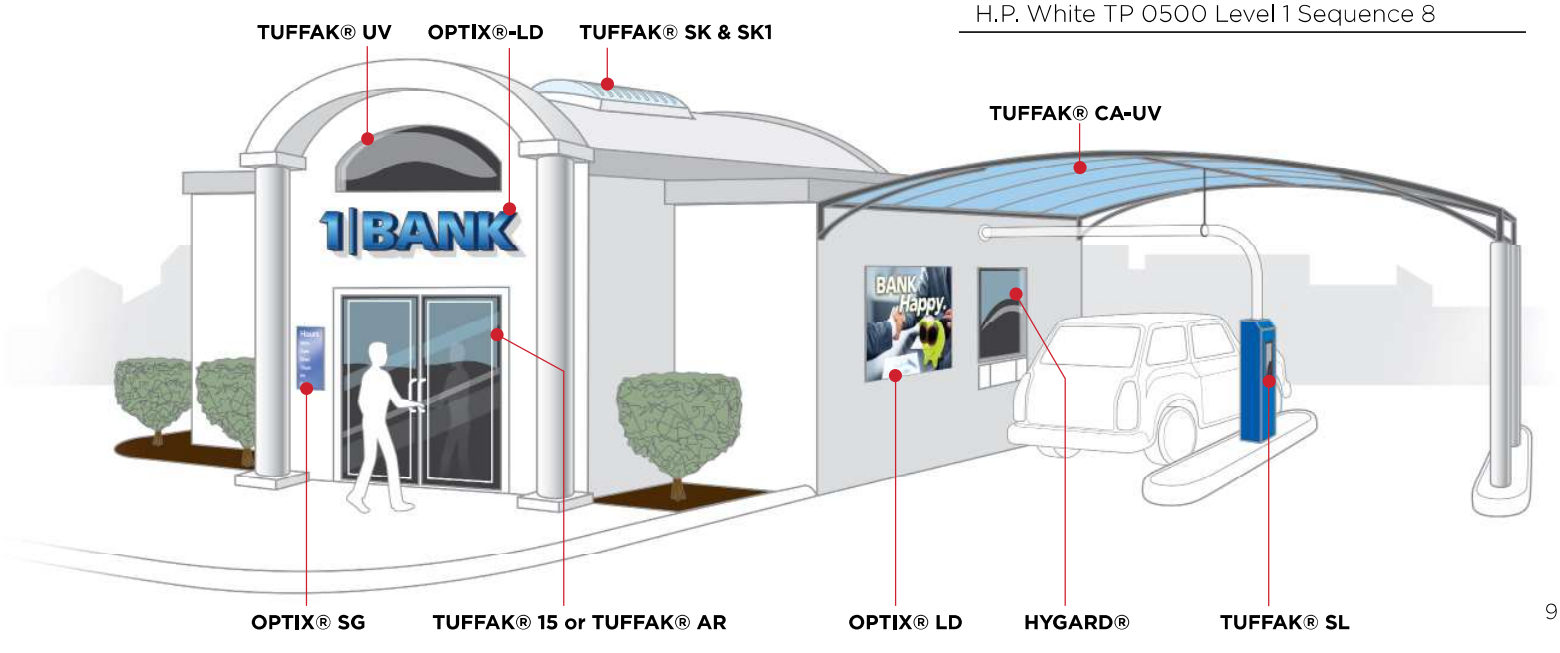
» Meets Florida's High Velocity Hurricane Zone (HVHZ) Test Standard

TUFFAK AR and Hygard polycarbonate are highly transparent products that, unlike glass-clad products, resist spalling and white-out after repeated high force impacts or ballistics, 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 F1233 Class 2.0 Body Passage
ASTM F1233 Class 1.4 Contraband Passage
ASTM F1915 Grade 3
H.P. White TP 0500 Level 1 Sequence 8



AMGARD™ TRANSPARENT SHEET FORMULARTED WITH A SILVER ION ANTIMCROBIAL AGENT THAT PROTECTS THE SURFACE FROM MICROORGANISM GROWTH

Safety Shields can help prevent the spread of airborne illnesses by creating a physical barrier between people, but they also present a surface for microorganisms to grow. Silver antimicrobial technology protects AMGARD surfaces from degradation by preventing the spread and growth of microorganisms. The technology is built into AMGARD during the manufacturing process and remains active for the life of the product.

Two certified laboratories have independently tested AMGARD to ISO 22196 "Measurement of Antimicrobial Activity on Plastics / Non-Porous Surfaces" – the industry standard for measuring Antimicrobial activity on Plastics and confirmed a reduction in the growth of microorganisms on the sheet surface.

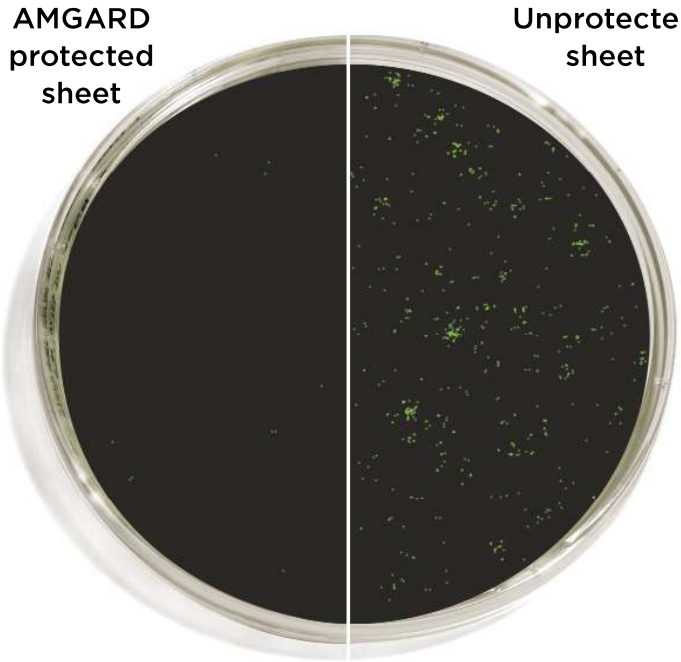
AMGARD is available in OPTIX® Acrylic and TUFFAK® Polycarbonate sheet options

- Protects surface against the growth of microorganisms such as bacteria, mold and mildew that cause stains and odors
- Provides additional surface protection between cleanings
- Tested to ISO 22196 "Measurement of Antimicrobial Activity on Plastics / Non – Porous Surfaces"

Product Comparison

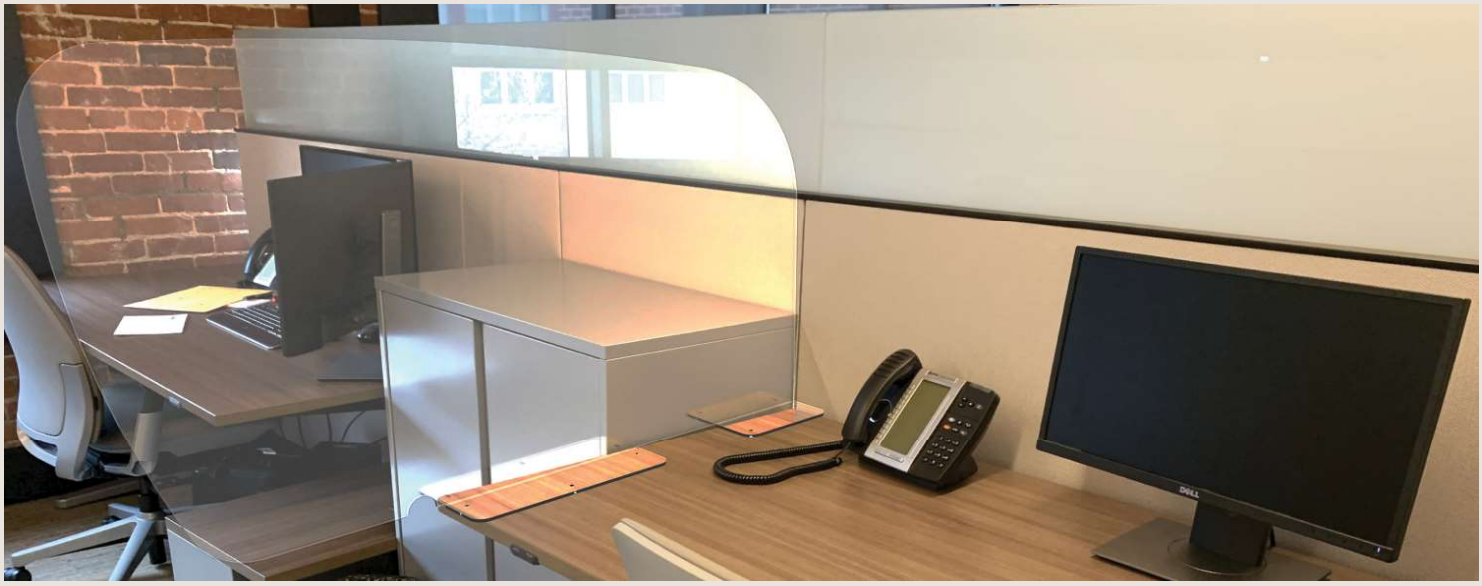
	Glass	Regular Sheet	AMGARD Sheet
Prevents Microbe Growth	No	No	Yes
Shatter Resistant	No	Yes	Yes
Lightweight	No	Yes	Yes

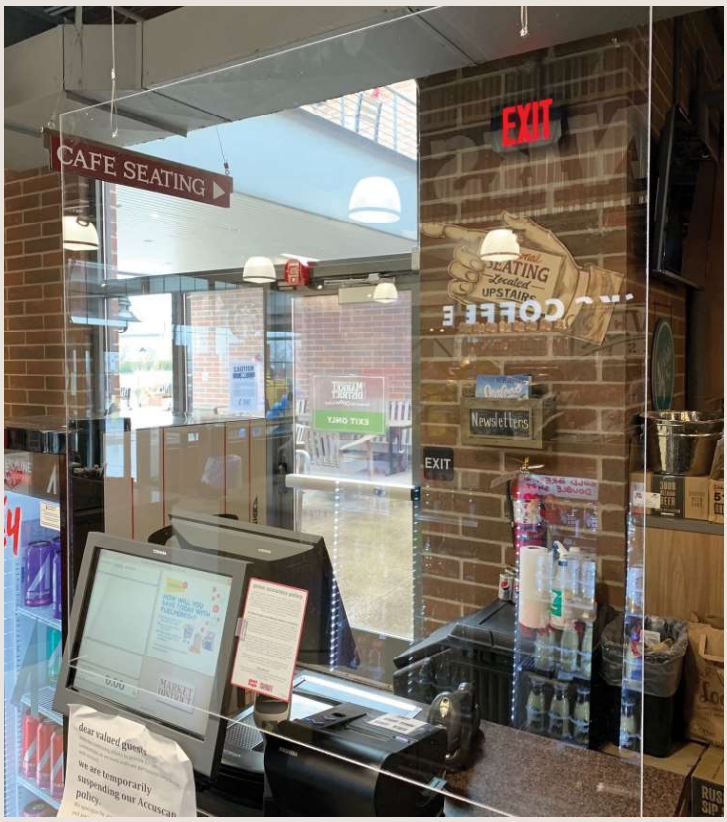
Representative 24-hour antimicrobial effect. AMGARD is formulated with silver ion antimicrobial technology to protect the sheet's surface. It is not designed to prevent the transmission of any disease or infectious agent.



AMGARD™ SR
SCRATCH-RESISTANT ANTIMICROBIAL ACRYLIC and polycarbonate sheet

- Inhibits microbe surface degradation
- Independent laboratory tested to ISO 22196 "Measurement of Antimicrobial Activity on Plastics / Non-Porous Surfaces"
- Abrasion resistant
- Chemical resistant
- Half the weight of glass
- Acrylic has excellent clarity
- Polycarbonate is virtually unbreakable
- Easy to fabricate & clean
- Indoor applications only





Withstands repetitive cleanings and high-traffic environments

TUFFAK® CA
CLASS A FLAMMABILITY RATING IN POLYCARBONATE SHEET

TUFFAK CA is an optical grade transparent polycarbonate sheet and designed to meet International Building Code (IBC) Class A flammability for interior wall and ceiling applications. This sheet product is virtually unbreakable, has high temperature resistance, high clarity and passes the National Fire Prevention Association (NFPA) 286 flammability requirement.

- Meets IBC flammability for Class A performance
- Passes NFPA 286
- UV stable
- Thermoformable
- Three approved methods for ceiling or wall mounting

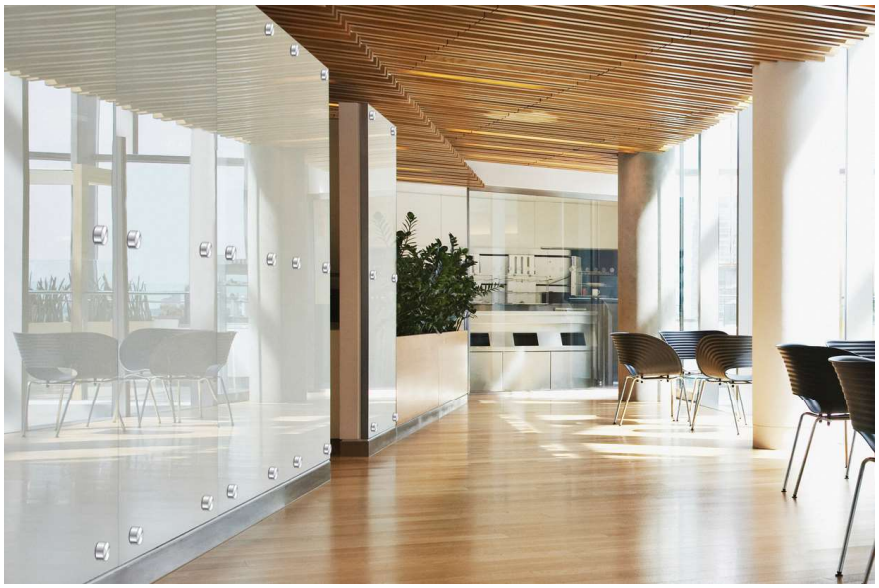
Gauges

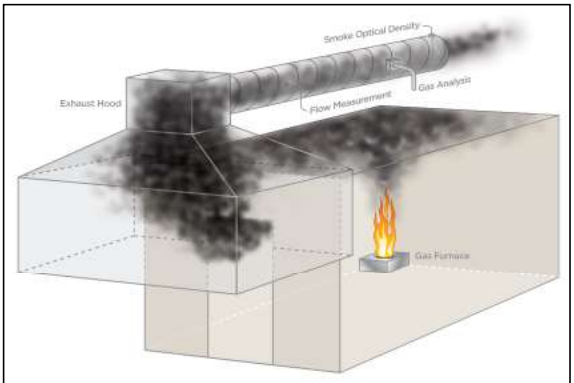
Walls: 0.118″– 0.236″

Ceilings: 0.118″– 0.500″

Colors

- Clear
- K09 Bronze
- I30 Gray (light)
- I35 Gray (dark)





NFPA 286, Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth

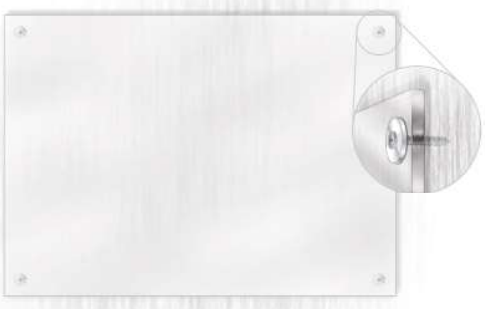
TUFFAK CA has been fire tested and certified in numerous installation configurations; both on and off wall and off ceiling.

For maximum fire resistance, TUFFAK CA meets IBC code compliance for Class A performance when installed as outlined below.

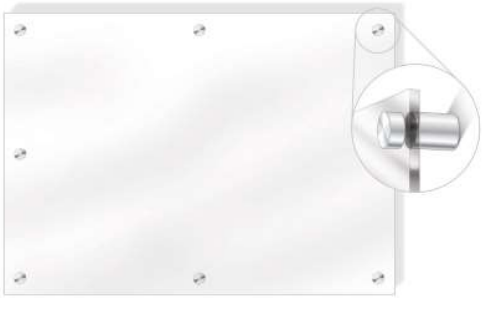
Grade	Location	Attachment	Gauge	Distance from Ceiling	Distance from Wall	Rating
TUFFAK CA	Ceiling	Spaced Standoffs	0.118″	2″		Class A Equivalent
	Ceiling	Spaced Standoffs	0.118″	12″		Class A Equivalent
	Ceiling	Spaced Standoffs	0.500″	2″		Class A Equivalent
	Ceiling	Spaced Standoffs	0.500″	12″		Class A Equivalent
TUFFAK CA	Wall	On wall at corners	0.118″		0″	Class A Equivalent
	Wall	On wall at corners	0.236″		0″	Class A Equivalent
	Wall	Spaced Standoffs	0.118″		0.5″	Class A Equivalent
	Wall	Spaced Standoffs	0.118″		6.0″	Class A Equivalent
	Wall	Spaced Standoffs	0.236″		0.5″	Class A Equivalent
	Wall	Spaced Standoffs	0.236″		6.0″	Class A Equivalent

TUFFAK® CA Mounting

Four Screw/Washer attachments mount panel directly on wall 1″ from corners



Cap/Barrel Stand-off attachment mounts for wall or ceiling standoff



TUFFAK CA-UV CLASS A FLAMMABILITY RATING / EXTENDED OUTDOOR SOLAR PROTECTION

TUFFAK CA-UV is a 2-sided UV protected, optical grade transparent polycarbonate sheet designed to meet International Building Code (IBC) Class A flammability for exterior applications. This sheet product is virtually unbreakable, has high temperature resistance, high clarity and passes the National Fire Prevention Association (NFPA) 286 flammability requirement.

» Meets IBC flammability for Class A performance

» Passes NFPA 286

» IBC 2018 Compliant

» Passes NFPA 286, Section 3105.3 for Canopy Materials

» 10 year Limited Warranty

» All standard Plaskolite colors

» 2-sided UV protection for extended outdoor use

» Thermoformable

» Cold bendable

GLAZING GUIDELINES FOR HYGARD

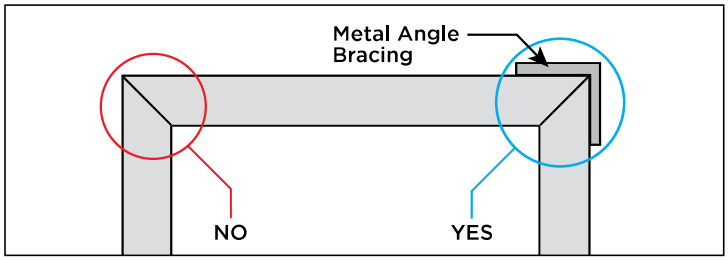
Frame design

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

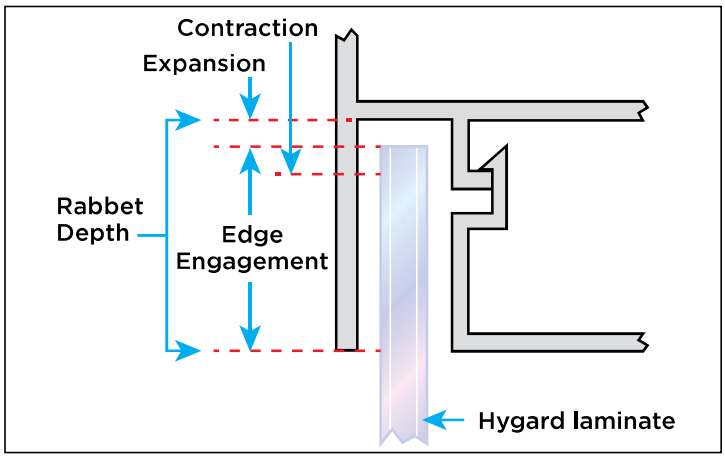
Corner design

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	Norrene® 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.

Norrene® is a registered trademark of Norton Company

GLAZING GUIDELINES FOR TUFFAK SHEET

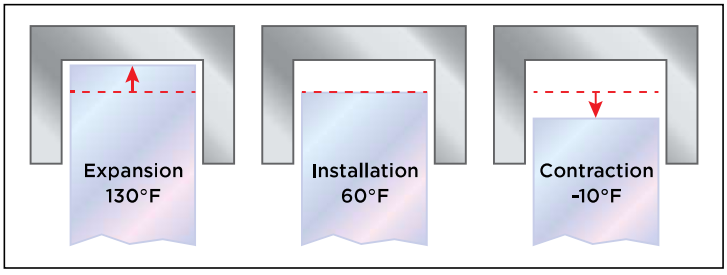
TUFFAK polycarbonate sheet can be installed using wet (caulking type sealant) or dry (gasket type) glazing systems. TUFFAK sheet can be glazed as a single layer, as two layers for added thermal insulation or over-glazed for increased security to an existing window.

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°F temperature change

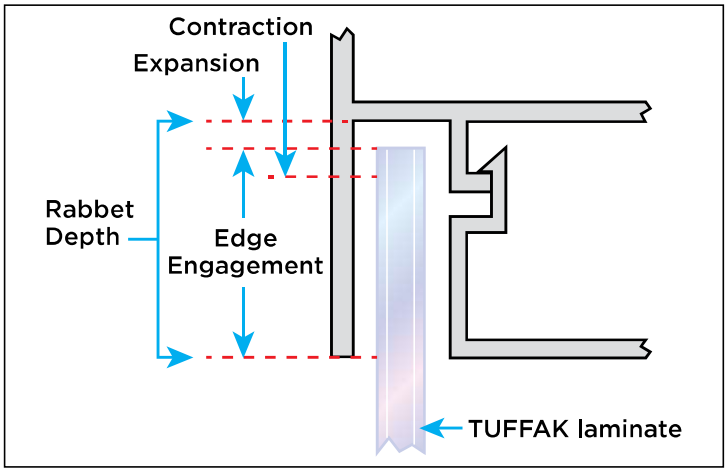
Calculation of Expansion/Contraction

0.0000375 x sheet dimension, inches x temperature change, °F

48″ expansion: 0.0000375 x 48″ x 70°F = 0.13″

48″ contraction: 0.0000375 x 48″ x 70°F = 0.13″

Rabbet depth:
Edge engagement + Expansion + 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

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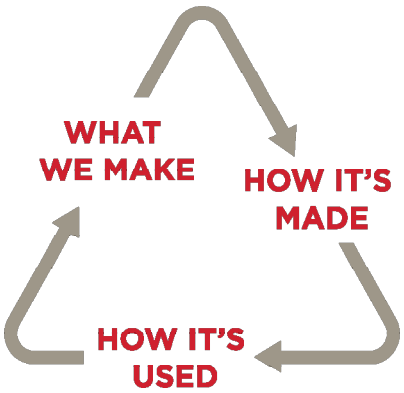

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