

TUFFAK[®] CM-2

Abrasion-Resistant Polycarbonate Sheet



TECHNICAL MANUAL

ALTUGLAS
INTERNATIONAL
ARKEMA GROUP



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I N T R O D U C T I O N

Tuffak[®] CM-2 is the Altuglas International designation for Tuffak polycarbonate sheet with a durable, clear coating that significantly increases the abrasion resistance of Tuffak sheet in typical exposures such as washing operations, airborne dust and dirt, and non-abusive public contact. In addition, the abrasion-resistant coating significantly increases the weatherability and chemical resistance of Tuffak sheet and has essentially the same physical properties of the Tuffak polycarbonate substrate. The effectiveness of Tuffak CM-2 polycarbonate sheet has been established by laboratory tests and outdoor weathering.

Tuffak CM-2 sheets are coated on one or both sides and shipped with a protective masking on both sides. The sheets are supplied in a wide range of standard sizes and thicknesses in both clear and transparent tints.

Tuffak CM-2 sheet finds wide use in glazing applications requiring abrasion resistance and weatherability combined with high impact resistance. Typical applications include architectural glazing, glazing for buses, trains and other mass transit vehicles, glazing for off-highway vehicles, and glazing for showcases protecting valuable displays and artifacts.

TUFFAK® CM-2 Abrasion-Resistant Polycarbonate Sheet**PHYSICAL PROPERTIES****ABRASION RESISTANCE**

Tuffak CM-2 sheet meets the abrasion resistance requirements of AS4 and AS5 of Federal Motor Vehicle Safety Standard #205 for glazing. Table 1 shows the results of various abrasion tests. This table illustrates the ability of Tuffak CM-2 polycarbonate sheet to withstand abrasion from typical architectural and rotary brush washing methods.

This coated sheet will not withstand intentional gouging with sharp objects such as keys, screwdrivers or knives, although no delamination of the coating will occur beyond the point of penetration. Once scratched or deeply gouged, the coating cannot be repaired.

IMPACT STRENGTH

Tuffak CM-2 sheet has the same impact strength as uncoated Tuffak sheet. Normally, Tuffak CM-2 sheet will not break or shatter when struck by thrown missiles such as rocks, bricks, or bottles. Tuffak CM-2 sheet meets the impact strength requirements of ANSI Z97.1 at 0.080" and above, and the CPSC Architectural Glazing Material Safety Standard (16 CFR 1201). In nominal .125" thickness, Tuffak CM-2 polycarbonate sheet meets the requirements for a burglary-resistant glazing material when tested in accordance with Underwriters' Laboratories Standard UL 972. In addition, Tuffak CM-2 sheet can be used for safety guards and other industrial plant applications that must meet OSHA requirements.

CHEMICAL RESISTANCE

Tuffak CM-2 sheet meets the chemical resistance requirements of Items AS4 and AS5 of Federal Motor Vehicle Safety Standard #205 for glazing. It resists attack from gasoline, kerosene, motor oil, liquid or felt-tip markers, spray paint and many other agents, as illustrated in Table 2. Contact with strong mineral acids, ketones, chlorinated hydrocarbons and aromatics should be avoided, especially along the edges of the sheet or abraded surface areas.

WEATHERABILITY

Tuffak CM-2 sheet now adds unsurpassed weatherability to the proven breakage resistance of polycarbonate plastic sheet. The weatherability of Tuffak CM-2 sheet has been confirmed by more than 4,000 hours of accelerated weathering tests and many years of actual outdoor weathering in transit glazing applications. Tuffak CM-2 polycarbonate sheet meets the weathering requirements of AS4 and AS5 of Federal Motor Vehicle Safety Standard #205 for glazing and ANSI Z97.1.

OPTICAL CLARITY

Tuffak CM-2 sheet has the same slightly higher transmittance and similar haze characteristics compared to uncoated Tuffak sheet. Both have adequate optical properties for window glazing applications.

MECHANICAL/THERMAL

Tuffak CM-2 sheet has the same mechanical and thermal properties as uncoated Tuffak sheet. These properties are given in Table 6.

CLEANING AND MAINTENANCE**NORMAL CLEANING**

To wash Tuffak CM-2 sheet by hand, use a water solution of mild soap, household liquid detergent or ammonia, or a recommended industrial cleaner from Table 3. Apply with a soft clean cloth, sponge or chamois; rinse well and dry with a soft clean cloth or soft rubber squeegee.

CLEANING TOUGH DEPOSITS AND GRAFFITI

To remove such deposits as glazing compound, masking paper adhesives, dried egg, paint, ink, and miscellaneous graffiti, follow the recommendations in Table 4. Cleaning with these agents should be followed immediately with a second cleaning using a solution of soap or detergent and water, and rinsing well.

Cleaning agents listed in Table 4 with numbers higher than 6 will attack the polycarbonate substrate through any scratches in the coating; however, they may be used momentarily on a surface with intact coating.



TABLE 1: Abrasion Resistance

Property	Typical Values ⁽³⁾		
	Test method	TUFFAK CM-2 (coated) sheet	TUFFAK A (uncoated) sheet
Eraser Abrasion Rating	(1)	0	5
Taber Abrasion (CS10F Wheel, 500 gms each wheel)	ASTM D-1044 ANSI Z26.1 Test #17		
Initial, % haze		<1.0	1.0
100 rev., % haze		<3.0	40.0
Steel Wool Rub Resistance	(2)		
0000 (superfine)		None	Heavy
00 (very fine)		Trace	Heavy
1 (medium)		Light	Heavy
3 (coarse)		Moderate	Heavy
⁽¹⁾ Visual ratings based on a scale of 0 to 5; 0=high abrasion resistance; and 5=poor abrasion resistance, i.e., uncoated polycarbonate abrasion resistance. ⁽²⁾ Ratings based on visual observation after 5 seconds of vigorous hand rubbing with each grade of steel wool. Ratings: none, trace, very light, light, moderate, heavy. ⁽³⁾ Not for specification purposes.			

Many of the solvents in Table 4 are flammable. They should be used in small quantities with good ventilation. There should be no smoking in areas where the solvents are stored or used. Employees should be protected from direct skin or eye contact with the liquids by use of protective equipment, such as impervious gloves, aprons and goggles where splashes are possible.

REMOVING GLAZING COMPOUND AND MASKING PAPER ADHESIVE

Glazing compound and masking paper adhesive can be easily removed from Tuffak CM-2 sheet with a soft cloth wet with VM&P naphtha or kerosene, followed by a thorough cleaning with soap and water. Do not scrape with a putty knife or other sharp instrument.

Do Not Use:

Do not use cleaners containing strong mineral acids or organic solvents such as ketones, chlorinated hydrocarbons and aromatics. The use of razor blades, putty knives or other sharp instruments should also be avoided, as they may scratch the material and, once scratched, the abrasion-resistant coating cannot be repaired.

FABRICATION PROCEDURES

MACHINING

Tuffak CM-2 sheet can be sawed, drilled and routed using the same tools and techniques recommended for uncoated Tuffak sheet. Tools must be sharp. Dull tools can cause chipping of the Tuffak sheet.

The sheet should remain masked during machining operation and the work surfaces should be kept clean and free from chips that could gouge the material. See the Tuffak Forming and Fabrication Manual (ADV980496) for complete fabrication information.

TABLE 2: Chemical Resistance Test Method ASTM D-1308

Chemical	Time to Visual Attack	
	TUFFAK CM-2 (coated) sheet	TUFFAK A (uncoated) sheet
Methylene Chloride (MDC)	4 hrs. (W,C)	1 min. (D,W)
Toluene	4 hrs. (W,C)	1 min. (D,W)
Solvesso™* 100	1 week	4 hrs. (W)
Kerosene	1 week	1 week
Acetone	48 hrs. (C)	1 min. (D,W)
Oxalic Acid	1 week	1 week
Hydrochloric Acid (conc.)	1 week	1 week (S,W)
Nitric Acid (conc.)	1 week (Y,C)	1 week (Y)
Sodium Hydroxide (sat.)	1 week (S,W)	48 hrs. (W)
Ammonium Hydroxide (conc.)	1 week	1 week
<p>Note: Teflon washer placed on surface, filled with chemical indicated and covered with a watch glass. Samples checked within 1 minute, 4 hours, 8 hours, 16 hours and then every 24 hours thereafter, for a total of 1 week. Code: S=slightly, W=whitened, C=crazed, Y=yellowed, D=dissolved.</p>		

*SOLVESSO 100 - expired trademark of Standard Oil Company.

CEMENTING

Tuffak CM-2 sheet cannot be cemented readily to itself or to other materials. To cement the sheet, remove by sanding or grinding the coating from the area to be cemented. After the coating is removed, the cements used for uncoated Tuffak sheet may be used. See the Tuffak Forming and Fabrication Manual for cementing instructions.

COLD FORMING

Tuffak CM-2 sheet can be cold formed, that is, bent while cold, to a smooth, moderate contour and held to that contour by springing the material into a curved channel support. The radius of curvature should be greater than that recommended for Tuffak A. Tight radii curves may cause crazing of the material.

CODES AND REGULATIONS

Tuffak CM-2 sheet installations should be used in conformance with applicable code requirements and regulations. These may include building and fire safety codes, safety glazing regulations, motor vehicle codes, industrial safety codes (including OSHA), and other applicable codes and regulations. Tuffak CM-2 sheet will meet most codes and regulations that set requirements for glazing materials. (See page 4 for fire considerations.)

Tuffak CM-2 polycarbonate sheet meets the requirements of a Class CC-1 light-transmitting plastic material under the model building code authorities: BOCA, ICBO and SBCCI. Tuffak CM-2 polycarbonate sheet meets the requirements of FRA Type I and Type II railroad glazing materials as defined in 49 CFR 223, Appendix A, as follows:

- Single glazing — nominal .460" thickness
- Double glazing — nominal .236" thickness with a .125" or .250" air space.

Check with Atoglas on applications where a standard is involved.



TABLE 3: Recommended Cleaners for TUFFAK CM-2 Polycarbonate Sheet

Mass Transit	
Cleaner	Supplier
C-1102	DuBois Chemicals
E.O. 479 Safe-Klean	Hexcel/Fine Organics
Key-Chem® 552	Key Chemical
Subway Soil Solvent Part I	Neleco
Subway Soil Solvent Part II	Neleco
Oakite® Fleetline® 205	Oakite Products
Magnus® NZL	Magnus Chemical/ Economic Lab
Architectural Cleaner Ammonium Hydroxide Concentrate (100%) Ammonium Hydroxide Concentrate (50% in water) Ammonium Hydroxide Concentrate (25% in water) Windex® Glass Wax® Glass Plus®	
Note: Since these cleaners are not manufactured or sold by Atoglas, the performance tests that we may run are necessarily limited to establishing only that a product has the potential to provide a necessary function. We cannot warrant that it will consistently maintain the required performance characteristics. We recommend that you contact the suppliers directly and have them verify that their product is safe for use with Tuffak CM-2 polycarbonate sheet.	

TUFFAK CM-2 AND FIRE

Tuffak CM-2 sheet must be used with an appreciation for the fact that it is a combustible material. Tuffak CM-2 sheet will burn when exposed to flame. The same fire precautions that are observed in connection with the handling and use of any ordinary combustible material should be observed when handling, storing, or using Tuffak CM-2 sheet.

TABLE 4: Graffiti Removal

Cleaning Agents <i>(listed in order from least to most harsh)</i>	
1. Rub with moistened flannel only	*6. Methanol
2. VM&P Naphtha	7. Toluene
3. Kerosene	8. Acetone
4. Soap or Detergent	9. Methyl Ethyl Ketone
5. Isopropanol	10. Methylene Chloride
*Cleaning agents with numbers higher than 6 will attack the polycarbonate substrate through any scratches in the coating; however, they may be used momentarily on a surface with intact coating.	
Type of Stain	Cleaning Agent Required To Remove Stain
Glazing Compound and Masking Paper Adhesive	VM&P Naphtha or Kerosene
Felt Markers	
Blaisdell Liquid Tip 1100, Black	Kerosene
Blaisdell Liquid Tip 1100, Red	Kerosene
Marsh 88 Marker, Black	Kerosene
Perm Color, Esterbrook®, Red	Kerosene
Sanford's® Marker Deluxe #69, Black	Isopropanol
Sanford's® Impact Marker #39, Blue	Kerosene
Sanford's® MR Sketch, Black	Water
Major Accent® #49, Orange	Water
Spray Paint	
Krylon® #1601, Glossy Black	Methanol
Note: In all cases, graffiti was applied at room temperature and allowed to dry 24 hours before removal. Stain was removed by rubbing with a flannel cloth saturated with the cleaning agent listed, starting with the least harsh.	

TABLE 5: TUFFAK CM-2 Sheet and Fire

Fire Response Characteristics	Recommended Practices
As is inherent in all polycarbonate materials, the ignition temperature of Tuffak CM-2 sheet is higher than that of most woods, but it will ignite. When involved in fire, Tuffak CM-2 sheet will burn and generate heat and smoke rapidly.	Install Tuffak CM-2 polycarbonate sheet away from sources of intense heat or flame. Enclose edges of Tuffak CM-2 sheet components. Observe building code stipulations and restrictions. Do not use more Tuffak CM-2 sheet than required to perform the function required of it. Employ fire protection systems—such as sprinklers, fire detectors, and automatic vents—as fire hazard analysis indicates.
Tuffak CM-2 polycarbonate sheet softens when heated above 275°F, which is below its self-ignition temperature of 1090°F.	Do not use Tuffak CM-2 sheet as a supporting element or in any location where resistance to fire penetration is required.
When burning, Tuffak CM-2 sheet will drip.	In overhead lighting, mount Tuffak CM-2 polycarbonate sheet in free channel mountings to ensure fallout prior to ignition. Extinguish burning Tuffak CM-2 with water or fire extinguishers.
When installed as a wall or ceiling finish or when laminated to a substrate, Tuffak CM-2 sheet provides a surface over which flame may spread and release heat and gases contributing to flashover.	Do not install Tuffak CM-2 sheet as applied wall or ceiling finish, or as a substrate surfacing material for large interior surface areas in building applications unless the areas are protected by an automatic sprinkler system.
Large-area installations of Tuffak CM-2 sheet, such as transparent enclosures, are not provided for in building code regulations, because they do not conform to area limitations. Therefore, these installations require special permits based on analysis of all relevant fire-safety considerations.	Relevant considerations are use of the structure (occupancy); location (exposure); height and area; nature of interior arrangement (decorations, finishes and furnishings); availability and construction of fire exits; need for special fire protection systems such as sprinklers, automatic heat and smoke vents, early warning devices and deluge systems or water curtains.
Burning Tuffak CM-2 sheet produces smoke. The concentration of carbon monoxide and/or carbon dioxide released by burning Tuffak CM-2 sheet is a factor of the quantity of Tuffak CM-2 involved and the conditions of burning.	The use of Tuffak CM-2 sheet may be restricted or prohibited in some locations because of high smoke generation. The use of Tuffak CM-2 is not restricted because of the toxicity of its products of decomposition.
Impact resistance of Tuffak CM-2 sheet may create entry and venting problems for firemen, as is the case for any polycarbonate sheet.	When possible, install Tuffak CM-2 sheet in operable windows. Fire departments and building occupants should be informed of the location of fixed Tuffak CM-2 sheet glazing in order to provide for alternative evacuation and venting facilities.

Building codes and standards define good practice in the use of Tuffak CM-2 sheet for light transmission and control on a design and engineering basis that takes into account the combustibility and fire characteristics of the material.

The fire hazard of uses of Tuffak CM-2 sheet can be kept at an acceptable level by complying with building codes and applicable standards, and observing established principles of fire safety. Listed in Table 5 are the fire response characteristics of Tuffak CM-2 sheet and recommended practices for design, engineering, and fire protection of Tuffak CM-2 sheet installations.

The high impact resistance of Tuffak CM-2 polycarbonate sheet may require the use of access panels by fire-fighting personnel for the evacuation and venting of rooms glazed with Tuffak CM-2 sheet in the event of fire. Consult local fire officials for their requirements.

Copies of the approvals of Tuffak CM-2 polycarbonate sheet under various codes will be made available on request. In addition, reports on the status of Tuffak CM-2 sheet under federal government regulations will be provided. Assistance will also be provided by Atoglas code consultants and engineers in interpreting the codes for installations of Tuffak CM-2 sheet that constitute justifiable exceptions to existing restrictions. A considerable amount of information is available to support such applications.



TABLE 6: Mechanical/Thermal Properties⁽¹⁾

Property	ASTM method	Units	TUFFAK CM-2 (coated) sheet	TUFFAK A (uncoated) sheet
Specific Gravity	D-792		1.2	1.2
Total White Light Transmittance ⁽²⁾	D-1003	%	89	87
Haze	D-1003	%	<1.0	1
Notched Izod ⁽²⁾	D-256	ft.-lbs./in. notch	16	16
Tensile Impact ⁽²⁾	D-1822	ft.-lbs./in. ²	170	170
Charpy Impact	D-256	ft.-lbs./1/2" x 1" section	NB	NB
Tensile Strength	D-638			
Ultimate		psi	8400	8400
Yield		psi	9500	9500
Elongation		%	100	100
Modulus		psi	3.4 x 10 ⁵	3.4 x 10 ⁵
Flexural Strength	D-790			
Maximum		psi	13500	13500
Rupture		psi	NB	NB
Deflection, Maximum		in.	0.07	0.07
Deflection, Rupture		in.	0.10	0.10
Modulus of Elasticity		psi	3.4 x 10 ⁵	3.4 x 10 ⁵
Shear Strength	D-732	psi	5800	5800
Rockwell Hardness	D-785	M Scale	70	70
Water Absorption (24 hrs.) ⁽²⁾	D-570	%	0.15	0.15
DTUFL at 264 psi	D-648	°C	135	135

⁽¹⁾ Values reported are averages and should not be used for specification purposes.
⁽²⁾ Test performed on 0.118" (3mm) thick specimens; all other test specimens 0.236" (6mm) thick. **Note:** NB=no break.

GLAZING INSTALLATION RECOMMENDATIONS

THERMAL EXPANSION AND CONTRACTION

The thermal expansion of Tuffak CM-2 sheet must be taken into consideration for the measurement and installation of Tuffak CM-2 sheet glazing. Before cutting the Tuffak sheet to size, accurately measure the inside width and height of each sash opening. Cut the height and width of Tuffak CM-2 sheet shorter than the overall inside sash opening dimensions to allow for thermal expansion by the amount shown in Table 7 for intermediate and large light glazing.

Unmask the Tuffak CM-2 sheet just prior to installation. Protect Tuffak CM-2 sheet from excess sealant smears with a paper-back adhesive tape around the edges adjacent to the rabbets. Thoroughly clean the

TABLE 7: Expansion Clearance for Intermediate and Large Light Glazing

Length	Clear	Tinted*
to 36"	1/16"	1/16"
to 60"	1/8"	3/16"
to 96"	3/16"	5/16"
to 132"	1/4"	3/8"
to 144"	5/16"	1/2"

*Less than 60% light transmission.

edges of the Tuffak CM-2 sheet with VM&P naphtha before setting it in the sash.

Tuffak CM-2 surface-protected sheet may show a temporary surface distortion when the masking is removed. This distortion will disappear immediately when warm water is applied. If not so treated, the distortion will disappear in several hours at room temperature.

TUFFAK® CM-2 Abrasion-Resistant Polycarbonate Sheet

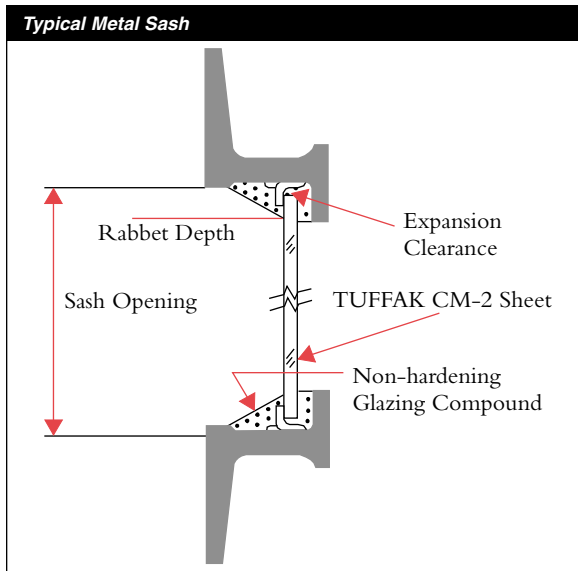
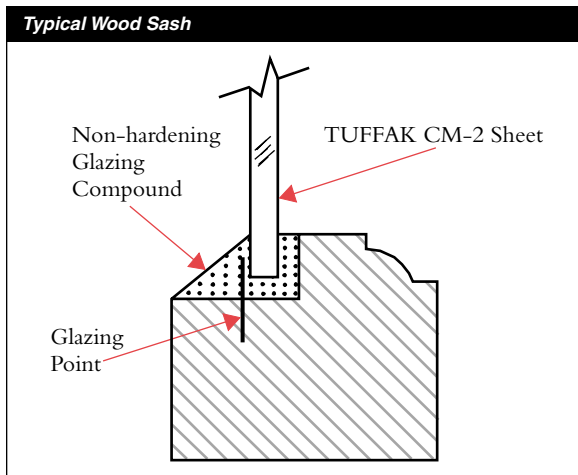
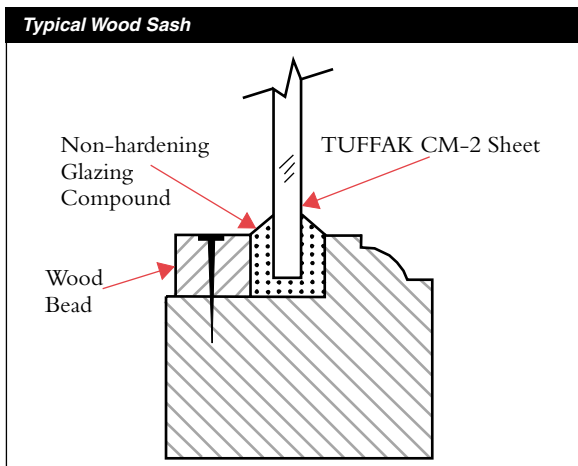
TABLE 8: Rabbet/Sash Dimensions (inches)

TUFFAK Sheet Thickness	Rabbet Dimensions		Maximum Sash Openings		
	Depth	Width	20psf	30psf	40psf
0.080"	3/8	1/4	24 x 33 30 x 30	24 x 30 26 x 26	24 x 27 -
0.080"	7/16	1/4	24 x 39 30 x 36 33 x 33	24 x 35 30 x 32 31 x 31	24 x 32 29 x 29 -
0.080"	1/2	1/4	24 x 44 30 x 41 36 x 39 38 x 38	24 x 40 30 x 37 34 x 37 -	24 x 36 30 x 33 31 x 31 -
0.080"	5/8	1/4	24 x 56 30 x 52 36 x 48 44 x 44	24 x 50 30 x 45 36 x 42 40 x 40	24 x 42 30 x 40 36 x 37 -
0.080"	3/4	1/4	24 x 63 30 x 60 36 x 58 42 x 54 48 x 51	24 x 54 30 x 51 36 x 48 42 x 46 44 x 44	24 x 48 30 x 46 36 x 44 41 x 41 -
0.093"	3/8	5/16	24 x 35 30 x 33 32 x 32	24 x 32 29 x 29 -	24 x 29 - -
0.093"	7/16	5/16	24 x 41 30 x 38 36 x 36	24 x 37 30 x 34 33 x 33	24 x 33 30 x 31 -
0.093"	1/2	5/16	24 x 46 30 x 43 36 x 41 40 x 40	24 x 42 30 x 39 36 x 36 -	24 x 39 30 x 36 33 x 33 -
0.093"	5/8	5/16	24 x 60 30 x 55 36 x 50 42 x 48 46 x 46	24 x 55 30 x 49 36 x 45 42 x 42 -	24 x 49 30 x 46 36 x 40 39 x 39 -
0.118" (3mm)	3/8	3/8	24 x 38 30 x 36 34 x 34	24 x 35 30 x 33 32 x 32	24 x 33 30 x 30 -
0.118" (3mm)	7/16	3/8	24 x 45 30 x 42 36 x 40 38 x 38	24 x 41 30 x 38 35 x 36 -	24 x 38 30 x 35 33 x 33 -
0.118" (3mm)	1/2	3/8	24 x 52 30 x 48 36 x 45 42 x 42	24 x 47 30 x 43 36 x 41 39 x 39	24 x 43 30 x 40 36 x 37 -
0.118" (3mm)	5/8	1/2	24 x 70 30 x 66 36 x 62 42 x 57 48 x 52	24 x 61 30 x 56 36 x 52 42 x 47 46 x 46	24 x 54 30 x 50 36 x 46 42 x 43 -



TABLE 8: Rabbet/Sash Dimensions (inches)

TUFFAK Sheet Thickness	Rabbet Dimensions		Maximum Sash Openings		
	Depth	Width	20psf	30psf	40psf
0.118" (3mm)	3/4	1/2	24 x 80 30 x 77 36 x 72 42 x 68 48 x 64	24 x 69 30 x 65 36 x 62 42 x 58 48 x 54	24 x 61 30 x 58 36 x 55 42 x 52 48 x 49
0.177" (4.5mm)	3/8	7/16	24 x 41 30 x 39 36 x 37	24 x 39 30 x 36 35 x 35	24 x 36 30 x 34 33 x 33
0.177" (4.5mm)	7/16	7/16	24 x 48 30 x 44 36 x 43 42 x 42	24 x 45 30 x 43 36 x 41 39 x 39	24 x 43 30 x 40 36 x 38 37 x 37
0.177" (4.5mm)	1/2	7/16	24 x 60 30 x 56 36 x 53 42 x 49 48 x 48	24 x 53 30 x 49 36 x 46 42 x 44 43 x 43	24 x 49 30 x 46 36 x 43 42 x 42 -
0.177" (4.5mm)	5/8	1/2	24 x 87 30 x 81 36 x 75 42 x 70 48 x 64	24 x 75 30 x 70 36 x 66 42 x 60 48 x 55	24 x 67 30 x 63 36 x 58 42 x 54 48 x 49
0.177" (4.5mm)	3/4	9/16	24 x 96 30 x 95 30 x 90 42 x 84 48 x 80	24 x 85 30 x 81 36 x 76 42 x 72 48 x 67	24 x 76 30 x 72 35 x 68 42 x 64 48 x 60
0.236" (6mm)	3/8	1/2	24 x 42 30 x 41 36 x 40 39 x 39	24 x 40 30 x 39 36 x 37 -	24 x 39 30 x 37 35 x 35 -
0.236" (6mm)	7/16	1/2	24 x 49 30 x 48 36 x 47 46 x 46	24 x 47 30 x 45 36 x 44 42 x 42	24 x 45 30 x 43 36 x 41 40 x 40
0.236" (6mm)	1/2	1/2	24 x 65 30 x 60 36 x 57 42 x 54 48 x 50	24 x 60 30 x 54 36 x 51 42 x 48 46 x 46	24 x 54 30 x 50 36 x 48 42 x 45 44 x 44
0.236" (6mm)	5/8	5/8	24 x 96 30 x 90 36 x 84 42 x 80 48 x 48	24 x 87 30 x 82 36 x 75 42 x 70 48 x 64	24 x 78 30 x 73 36 x 68 42 x 63 48 x 57
0.236" (6mm)	3/4	5/8	24 x 96 30 x 96 36 x 96 42 x 96 48 x 92	24 x 96 30 x 94 36 x 90 42 x 84 48 x 79	24 x 89 30 x 84 36 x 80 42 x 75 48 x 70
0.236" (6mm)	1	5/8	42 x 96	69 x 96	48 x 96

INSTALLATION DETAILS**SMALL LIGHT GLAZING****FIGURE 1****FIGURE 2****FIGURE 3****TEMPERATURE/HUMIDITY BOWING**

Different temperature and/or humidity conditions on the inner and outer surfaces of Tuffak CM-2 sheet glazing may cause the sheet to bow somewhat in the direction of the higher temperature and/or humidity. However, this type of bowing is reversible, and the sheet will return to its original flatness when the temperature and humidity differentials are equalized. Bowing does not affect visibility through flat transparent Tuffak CM-2 sheet glazing, but it may cause distorted reflection.

Step By Step Preparation

1. Ascertain from Table 8 the thickness of the Tuffak CM-2 sheet and the corresponding rabbet dimensions. Where unusual temperature or humidity conditions exist, special engineering analysis may be required.
2. Ascertain from Table 7 the recommended thermal expansion clearances for Tuffak CM-2 sheet in the sash for both horizontal and vertical dimensions.
3. Be aware that the rabbet depth listed in Table 8 and the expansion clearance from Table 7 do not include tolerances in size and squareness of the installed sash. Cut Tuffak CM-2 sheet to meet each field-measured sash opening. Also know that the expansion clearance and sealant width shown in Figures 4 and 5 are based on cutting Tuffak CM-2 sheet to size and installing the sealants in ambient temperatures near 70°F. Ambient temperatures that vary more than $\pm 20^\circ\text{F}$ from this median will require adjustment in the expansion clearance and sealant width.
4. Cut the Tuffak CM-2 sheet to size using a band, hand, saber or circular saw or a power shear. It's not likely the Tuffak CM-2 sheet will chip or crack during cutting.
5. Make sure the Tuffak CM-2 sheet edges are smooth and free of chips and hairline cracks.
6. Remove all projections and old sealing compounds from the old sash. Also remove oil and grease and prime, if necessary.
7. Wipe sash with a clean dry cloth.
8. Apply a continuous filler tape, such as a polyethylene or polyurethane foam of medium density. More dense or firmer filler tapes will require a bond breaker between the tape and the sealant.



SEALANTS FOR TUFFAK CM-2 GLAZING

Limited thermal and load movements in small sheet sizes (up to 24" x 24") allow use of a variety of non-hardening caulking compounds. These compounds range in both cost and quality of performance from oil-based caulks to the better acrylic latex caulks. Caulking compounds offer advantages in respect to cost and ease of application compared to the high-performance elastomers, such as silicones and polysulfides that are required for larger sheet sizes.

As shown in Figure 4, all intermediate Tuffak CM-2 sheet sizes are channel glazed. A gunned-in sealant bead 1/4" wide and 1/4" deep is specified for all sizes within the intermediate range (up to 72" x 72"). The distance between the fixed and removable stops must be no less than the thickness of the Tuffak CM-2 glazing, plus the specified minimum 1/4" sealant width. The 1/4" sealant depth is set by inserting the continuous filler tape between the exterior stop and the Tuffak CM-2 sheet. Gun-grade acrylic latex caulks that allow 15% joint movement may be used for intermediate light sizes up to a maximum of 36" x 36". Beyond this size, one of the high-performance silicone or polysulfide sealants listed in Table 9 must be used.

All large sheets up to 120" x 144" are glazed in a channel system where the legs of the channel are the fixed and removable stops as illustrated in Figures 4 and 5. Required rabbet dimensions are listed in Table 8 for various sash openings, loads, and Tuffak CM-2 sheet thicknesses. The rabbet width specified provides the proper sealant width that is essential to accommodate combined wind, thermal, and humidity movements in the Tuffak CM-2 sheet. The depth of the sealant is a constant 1/4" for all sheet sizes and again is set by inserting a filler tape in-between the Tuffak CM-2 sheet and the exterior stop.

High-performance polysulfide and silicone sealants have joint movement capability ranging from $\pm 25\%$ to $\pm 50\%$. Only those sealants capable of $\pm 50\%$ joint movement should be used for Tuffak CM-2 sheet sizes larger than 96" x 96".

INSTALLATION DETAILS

INTERMEDIATE AND LARGE LIGHT GLAZING

FIGURE 4

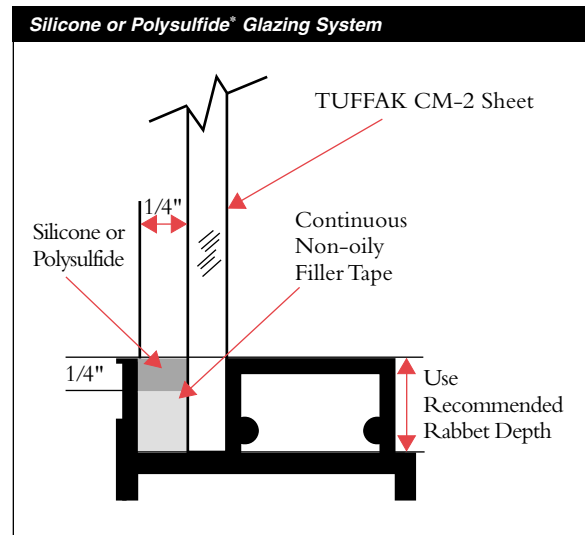
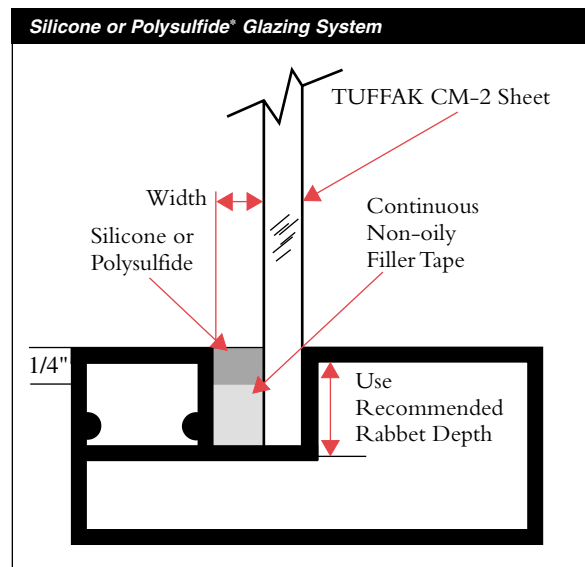


FIGURE 5



* In some cases, primers are required.
Follow sealant manufacturer's recommendations.

TABLE 9: Sealants

Sealant Manufacturer	Sealant	Joint Movement
General Electric Company	Silicone-Silglaze	±25%
	Silicone-Silglaze	±50%
Dow Corning	Silicone	±50%
Tremco	Polysulfide- Lasto-meric™ (2 part)	±25%
DAP Inc.	Polysulfide- Flexiseal (2 part)	(not listed in reference)

Listed in Table 9 are sealant manufacturers and the approximate joint movement capability of their sealants. Sealants and sealant dimensions listed by Altuglas are only indicative of required compatibility and joint movement. Sealants are listed as a selection guide and are not intended to exclude the sealants of other manufacturers. Sealant preparation, application and performance are the responsibility of the sealant manufacturer. Arkema Inc. does not guarantee sealant performance.

HEALTH AND SAFETY PRECAUTIONS

Machining Tuffak CM-2 sheet will cause localized heating and may generate gases, vapors, and polymer dust. Machining Tuffak CM-2 sheet in areas with adequate ventilation* should not result in harmful concentrations of gases or vapors. However, it is always good practice to provide local exhaust ventilation as close to the point of possible generation of vapors as practical.

Any dust produced by the machining of Tuffak CM-2 sheet is considered nuisance dust. The American Conference of Governmental Industrial Hygienists recommended TLV for nuisance dust is 10 mg/m³—total dust, and 5 mg/m³—respirable dust.

Worker exposure to dust can be controlled with adequate ventilation,* vacuum dust removal at the point of generation, or in the use of suitable protective breathing devices.

Before using any chemical suggested in this bulletin (e.g., cement, solvent, adhesive, sealant, or cleaner, etc.) the user should become familiar with the properties of the product to be used and the precautions necessary for its safe usage. Material Safety Data Sheets should be obtained from the manufacturer for these purposes.

*Suggestions for the design of exhaust ventilation are provided in *Industrial Ventilation—A Manual of Recommended Practice*, published by the American Conference of Governmental Industrial Hygienists (1988) and American National Standards Institute, *Fundamentals Governing the Design and Operation of Local Exhaust Systems*, Z9.2-1979.



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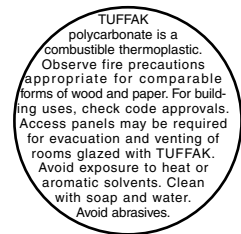
TUFFAK® CM-2 Abrasion-Resistant Polycarbonate Sheet

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See MSDS for health and safety considerations.

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