



# PALSUN<sup>®</sup> Technical Guide

Flat Solid Polycarbonate Sheet



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## PALSUN® Product Range

Some of the products' features below can be combined. Please contact your Palram dealer for further information.

Product	Description	Features & Applications
PALTUF®	UV stabilized, general purpose, flat solid polycarbonate sheet.	Recommended for indoor use only.
PALSUN®	Flat solid polycarbonate sheet with UV protective layer on one side.	Suitable for both exterior and indoor applications.
PALSUN® UV2	Flat solid polycarbonate sheet with UV protective layer on both sides.	Recommended for applications that involve UV exposure on both sides (e.g. exterior light boxes)
PALSUN® Embossed	Flat solid polycarbonate sheet with optional surface textures: Embossed (E-102), Prismatic, Hair-cell, Matte - Anti-glare effect.	Recommended for applications that involve UV exposure on both sides (e.g. exterior light boxes)
PALSUN® FR	Sheet with higher fire resistance rating (e.g. UL 94 V-0).	Recommended for applications in populated areas.
PALSUN® Solar Control	Sheet with integrated heat-blocking layer. This metallic reflective layer that transmits less Infrared radiation and reduces heat buildup.	Available with 20, 35, or 50% light transmission.
PALSUN® Breeze	This advanced heat-blocking SolarSmart™ tint offers a clear view due to its high clarity.	Can be tailored to achieve different light and heat transmissions.
PALGARD™	Sheet with abrasion resistant layer on one or both sides.	Recommended for applications in high traffic areas, harsh chemical environments or those requiring anti-vandal properties.
PALSHIELD™	Containment and bullet resistant panel	Recommended for security glazing in banks and government facilities, public institutions, gas stations and convenience stores.

- Notes:
1. All the above sheets are supplied with a protective polyethylene (PE) film on both sides (one side upon request), with the UV protected side clearly marked. This film should be removed immediately after installation.
  2. For transportation, handling and storage instructions and recommendations, please refer to [Handling and Storage Guidelines for Palram Sheets](#).
  3. PALSUN sheets are backed by a 10 years limited warranty, available upon request.
  4. Most PALSUN sheets are available in the transparent, translucent or opaque form, in a variety of colors, either standard or custom ordered.

## Standard Dimensions\*

Thickness (mm)	Width x Length (mm)	Surface Finish				
		Smooth Both sides	Embossed Both sides	Matte One side	Hair Cell One side	Prismatic One side
1	1220 x 2440	✓		✓		
1.5	1250 x 2440	✓	✓	✓		
2		✓	✓	✓		
2.5 - 6	1220 x 2440 1250 x 2440	✓	✓	✓	✓	✓
8	2050 x 3050	✓	✓		✓	
9 - 12.7		✓			✓	
2 - 18	2450 x 3050	✓				

\*Other dimensions and specifications are available upon request, subject to a minimum order.

# Colors

Color Group	Description	Colors
Clear	Transmits up to 90% natural daylight, resulting in high lighting within the structure.	Clear
Transparent	Low haze colors offering high clarity. Breeze and Smart are SolarSmart™ colors with that reduce heat buildup while allowing a clear view through the sheet (see page 9 for more details on SolarSmart products).	
Translucent	<p><b>White Opal:</b> Transmits 11-50% visible light with high light dispersion, produces mild and even lighting within the structure.</p> <p><b>Diffuser:</b> Transmits 50% visible light with high light dispersion, produces diffused and consistent lighting within the structure.</p> <p><b>LB (Light Box):</b> Diffuser sheet for illuminated signs and display applications, offering 44-50% light transmission.</p>	
Opaque*	Colors that transmit very little to no light.	

\* Subject to minimum quantity. Custom colors and light transmissions are also available in this manner.

\*\* Colors shown above are a reproduction of the actual color. To accurately represent the colors, contact your Palram distributor and request a sample color chip.



## SolarSmart™ - Energy Efficiency

SolarSmart™ are energy-efficient colors break the traditional ratio between light transmission and shading coefficient. SolarSmart™ panels block Infrared energy that causes heat buildup, and transmit "cool light" that reduces air-conditioning and lighting costs.

More energy-saving, natural visible light is transmitted.



Blocking Infra-Red reduces heat buildup.

SolarSmart™ Panel

## Physical Properties

The following table displays physical properties of 3mm (0.12 inch) PALSUN and PALTUF sheets.

Property	Method**	Conditions (U.S. Customary)*	Units - SI (U.S. Customary)*	Value (U.S. Customary)*
<b>Physical</b>				
Density	D-792		g/cm <sup>3</sup> (lb/ft <sup>3</sup> )	1.2 (75)
Water Absorption	D-570	24 hr. @ 23°C	%	0.15
<b>Mechanical</b>				
Tensile strength at yield	D-638	10 mm/min (0.4 in./min)	MPa (psi)	62.5 (9,100)
Tensile strength at break	D-638	10 mm/min (0.4 in./min)	MPa (psi)	65 (9,500)
Elongation at yield	D-638	10 mm/min (0.4 in./min)	%	6
Elongation at break	D-638	10 mm/min (0.4 in./min)	%	>80
Tensile Modulus of Elasticity	D-638	1 mm/min (0.4 in./min)	MPa (psi)	2,300 (290,000)
Flexural Modulus	D-790	1.3 mm/min (0.052 in./min)	MPa (psi)	2,350 (343,000)
Flexural Strength at Yield	D-790	1.3 mm/min (0.052 in./min)	MPa (psi)	93 (13,600)
Notched Impact Strength Izod	D-256	23°C (73°F)	J/m (ft-lbf/in.)	800 (15)
Notched Impact Strength Charpy	D-256	23°C (73°F)	J/m (ft-lbf/in.)	800 (15)
Impact Falling Weight	ISO-6603/1b		J (ft-lbf)	158 (117)
Rockwell Hardness	D-785		R scale / M scale	125 / 75
<b>Thermal</b>				
Long Term Service Temperature			°C (°F)	-50 to +100 (-175 to +212)
Short Term Service Temperature			°C (°F)	-50 to +120 (-175 to +250)
Heat Deflection Temperature	D-648	Load: 1.82 MPa (264 psi)	°C (°F)	135 (275)
Vicat Softening Temperature	D-1525	Load: 1 kg (2.2 lb)	°C (°F)	150 (300)
Coefficient of Linear Thermal Expansion	D-696		mm/m °C (Mil/in. °F)	0.065 (0.036)
Thermal Conductivity	C-177		W/m K (Btu-in/hrft <sup>2</sup> °F)	0.21 (1.46)
Specific Heat Capacity	C-351		kJ/kg·°K (Btu/lb·°F)	1.26 (0.31)
<b>Optical</b>				
Haze	D-1003	Clear Sheet	%	<0.5
Light Transmission	D-1003	Clear Sheet	%	89
Refractive Index	D-542	Clear Sheet		1.586
Yellowness Index	D-1925	Clear Sheet		<1
<b>Electrical</b>				
Dielectric Constant	D-150	50 Hz		3.0
	D-150	1 MHz		2.9
	D-150	1 KHz		0.001
Dissipation Factor	D-150	1 KHz		0.001
	D-150	1 MHz		0.01
Dielectric Strength Short Time	D-149	500 V/s	kV/mm (V/mil)	>30 (>770)
Surface Resistivity	D-257	Keithley	Ohm	10 <sup>16</sup>
Volume Resistance	D-257	Keithley	Ohm-cm	10 <sup>17</sup>

\* Conditions, units and values in U.S. Customary units are presented in the table within parentheses.

\*\* ASTM except where noted otherwise.

## Impact Strength

PALSUN sheets are manufactured from polycarbonate, the most versatile, toughest transparent thermoplastic. PALSUN has 200 times the impact strength of glass, offering excellent protection against riots and public disturbances, breaking & entering or acts of vandalism.

PALSUN can endure attacks by rocks, clubs, hammers and thrown objects, and still to retain its original shape, maintain its integrity with minimal indentations to its surface.

The amount of damage depends on the object mass and energy, and sheet's thickness. PALSUN sheets will retain these energy-absorbing properties over a wide temperature range (50° to + 100° C).

### Typical impact failure energy of PALSUN® sheets\*

Thickness mm	Energy at Failure E <sub>50</sub> (Joules)	Type of Failure
2	110	100% ductile
3	150	100% ductile
4	190	100% ductile
5	290	100% ductile
6	400	100% ductile
8 - 18	N.B.**	N.B.**

\* According to ISO 6603/1 1985(E): Determination of multi-axial impact behavior of rigid plastics.

### Falling Dart Method

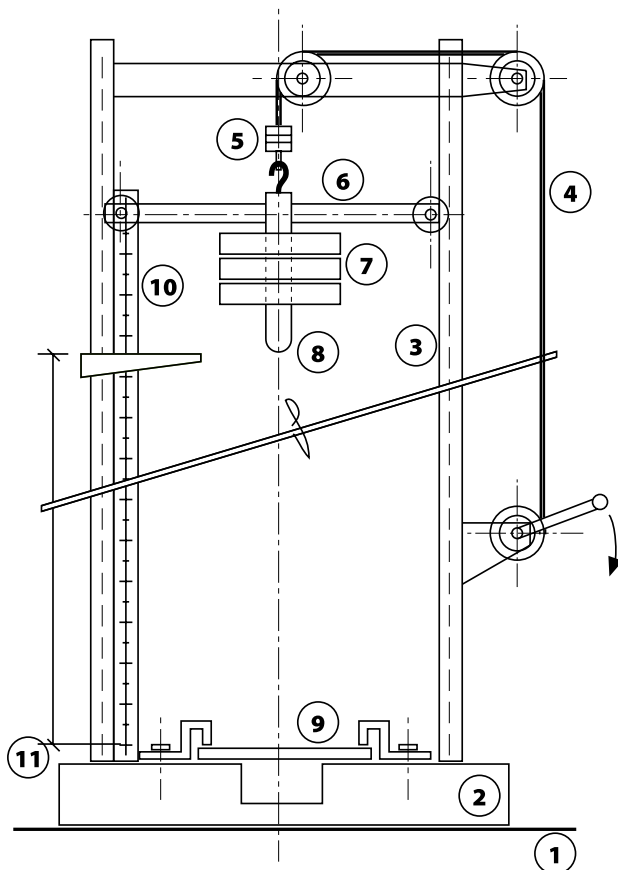
A uniform energy increment is employed during testing. Energy is decreased or increased by uniform increment after testing each specimen, depending upon the result (failed / not failed) observed for the former tested sample. A 20 mm diameter dart, weighing 8 kg, with a rounded tip, is raised to a certain height and released to fall on a suitably sized sample.

**Principles:** Impact strength is determined by the known weight and height. Adjustment is done by altering height while using a constant mass.

**E50:** 50% of Impact Failure Energy. The energy that will cause 50% of the tested samples to fail.

**N.B.\*\*:** No Break. The energy required to break the sample is greater than what the test instrument can deliver.

### Falling Dart Impact Testing Device (Schematic Figure)

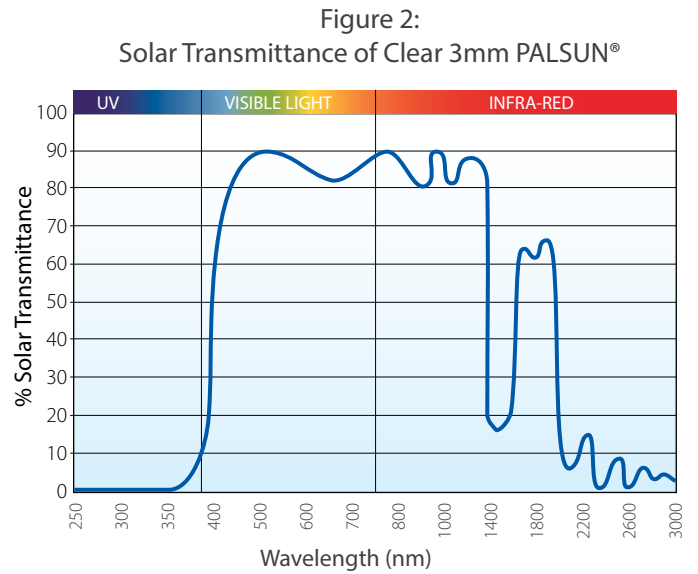


### Legend

1. Leveled floor
2. Stabilized base
3. Supporting guidrails
4. Lifting mechanism
5. Disengagement mechanism
6. Guidance bar
7. Changeable weight
8. 20 mm diameter head falling dart
9. Tested specimen
10. Calibration bar
11. Changeable drop height

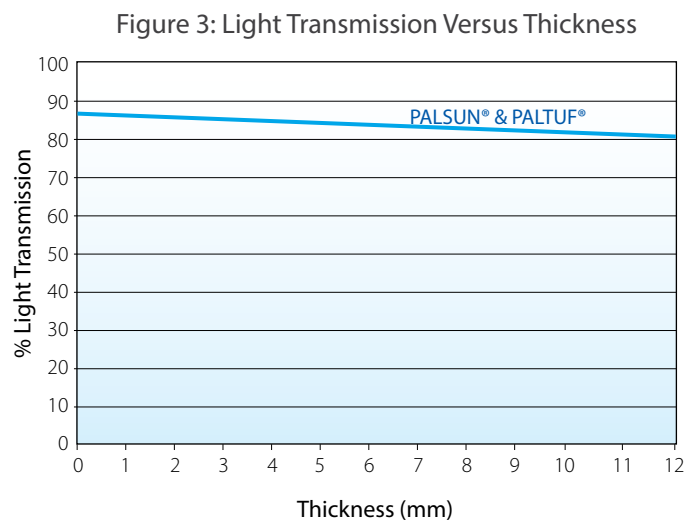
## Optical Characteristics

Ultraviolet (UV) Radiation Blocking - PALSUN sheets completely block out potentially harmful UV radiation and a significant portion of Infrared (IR) radiation. Over the visible light range, a typical 3 mm (0.125 inch) thick clear PALSUN sheet transmits about 89% (average) of incident light, as seen in the attached graph.



### Light Transmission Versus Thickness

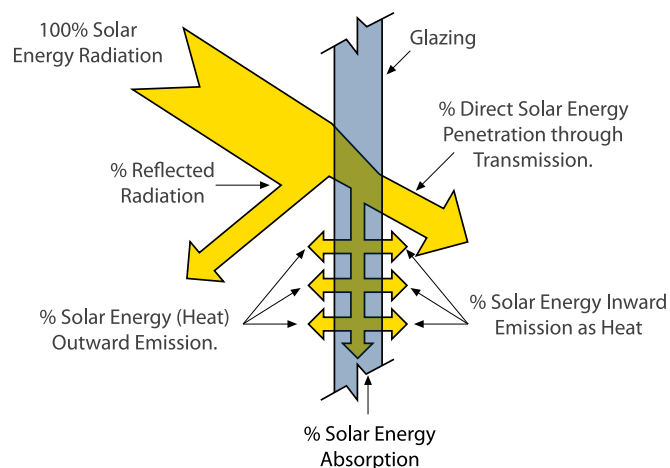
Light transmission decreases slightly with increased thickness (see attached graph).



## Solar Transmission Properties

Solar energy transmission is an extremely important consideration with transparent materials. Geographic location and typical thermal/optical properties of the specific glazing are the main factors influencing solar heat gain. Various types of PALSUN - textured, tinted, opal, diffused, and heat blocking SolarSmart™ sheets - can be used to deliver the exact quantity and quality of light desired. Each of these products transmit different amounts of direct light in varying levels of light diffusion, which may help to spread the light throughout the structure or enclosure. The sheets also vary in their selectivity index (SI) values, which determines how efficiently they keep heat out while letting more “cool light” in (See [next page](#) for more information on SolarSmart™ products). Although colors and tints reduce the percentage of visible light transmitted through the sheets, but solar energy is still absorbed by the glazing itself, and in turn transferred by convection and far IR radiation from the heated glazing into the building. PALSUN sheets with embossed or matte surfaces, or diffuser colors, diminish glare and dazzle, preventing damage by direct irradiance. However solar energy is still transmitted through and increases the solar heat gain inside the structure.

Figure 4: Solar Radiation Schematic Behavior Through Light Transmitting Material



Color*	% Light Transmission ASTM D-1003	%Haze ASTM D-1003	Solar Heat Gain (SHGC) ASTM E-424-71	Shading Coefficient ASTM E-424-71
Clear	90	<1	0.87	1.00
	20	<1	0.45	0.52
Bronze	35	<1	0.56	0.64
	50	<1	0.65	0.75
Solar Grey	20	<1	0.44	0.51
	35	<1	0.56	0.64
White Opal	50	<1	0.65	0.75
	28	100	0.32	0.37
White Diffuser	80	100	0.87	1.00
Solar Ice	20	100	0.37	0.45
Solar Control	20	67	0.33	0.36
	35	52	0.45	0.52
	50	50	0.54	0.61
Solar Olympic	20	35	0.41	0.47
	35	20	0.52	0.60
Smart Green	50	63	0.63	0.73
	70	42	0.58	0.67
Smart Blue	70	42	0.57	0.65
Bluish Breeze	70	42	0.55	0.63

\*Values in the table above relate to 3mm Sheet. Further information on additional products is available upon request.

### Terminology Used in the Table

**Solar Radiation:** The solar spectrum ranging from 300 nm to 2400 nm. Included are UV, visible and Near-IR radiation.

**Visible Light Radiation:** The portion of the light spectrum whose wavelength ranges from 400nm to 780nm.

**% Light Transmission (ASTM D-1003):** Percentage of incident visible light that passes through an object.

**% Solar Heat Gain (SHGC):** The percent of incident solar radiation transmitted by an object which includes the direct solar transmission plus the part of the solar absorption reradiated inward.

**Shading Coefficient (ASTM E424-71):** The ratio of the total solar radiation transmitted by a given material to that transmitted by normal glass, whose light transmission is 87%. It can be approximately calculated by:  $\%ST + (0.27 \times \%SA) = \%ST_t$   $SC = (1.15 \times ST_t)/100$



## SolarSmart™ Technology - Efficient Daylighting



Enjoy light without heat.



### Promoting Energetic Efficiency and Well Being

SolarSmart technology defies standard transmission of solar energy in transparent sheets and allows more versatile color and solar transmission specification per project. Unlike regular tints, SolarSmart sheets and panels admit more natural daylight while reflecting outwards Infrared radiation that creates heat. This characteristic breaks the traditional link between shading coefficient and light transmission, allowing a different perspective on the specification of natural light in architectural design.

SolarSmart tints allow better use of natural lighting without sacrificing the interiors. More natural light results in a healthier and more productive ambience. Energy saving is also promoted through reduction of both illumination and air conditioning requirements.



### Color Specification

SolarSmart™ tints can be applied to any Palram transparent polycarbonate sheet or panel system, including PALSUN. The tints can be blended with any color to tailor the desired appearance and solar properties.

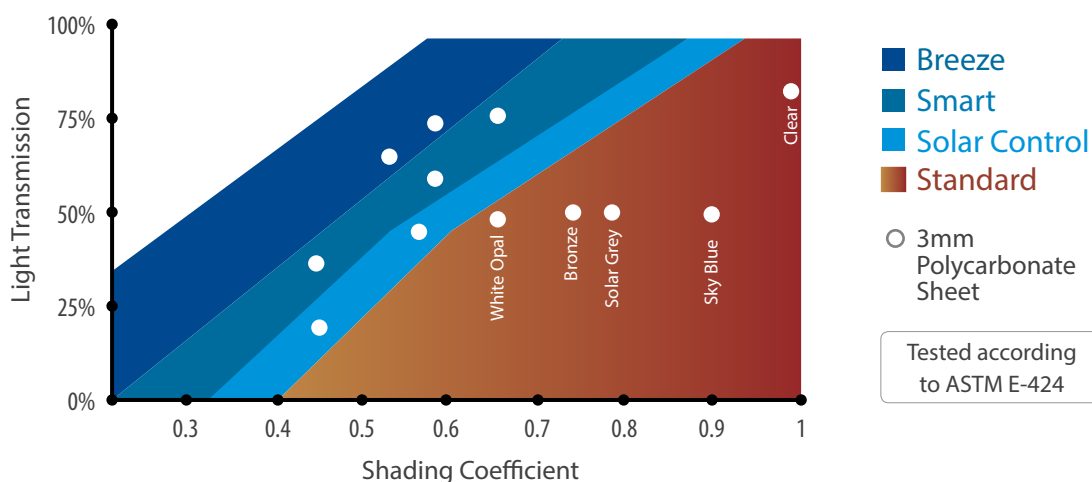


### Technology Groups

The SolarSmart product range includes 3 technology groups, which have different characteristics and appearance. For more information please refer to the [SolarSmart™ Technology brochure](#).

### Efficiency Comparison

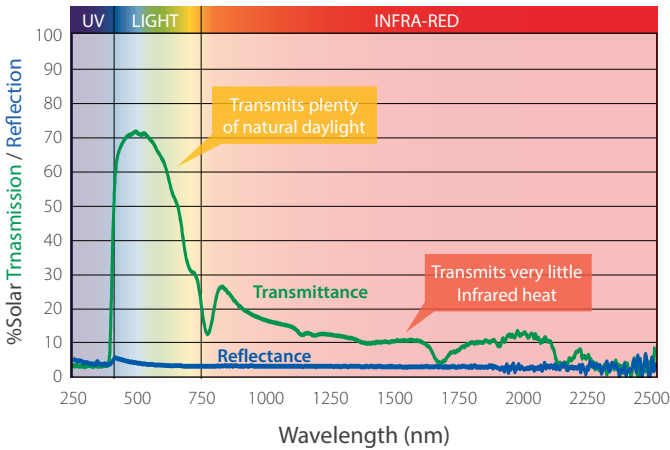
The graph below demonstrates the efficiency of SolarSmart products in comparison with clear and standard colored sheets. The graph shows how SolarSmart™ tints enable higher light transmission specification while maintaining or decreasing shading coefficient values.



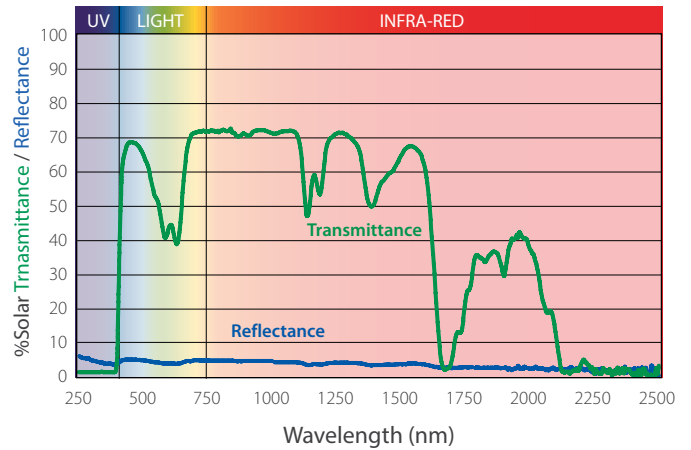
## Heat-Blocking with High Clarity by PALSUN® Breeze

PALSUN glazing with Breeze tint transmits plenty of incident daylight (70%), while absorbing/blocking a large portion of the Infrared radiation, thus significantly reducing heat buildup within the structure. PALSUN Breeze also provides a clear view due to its high transparency, which is uncommon for heat-blocking products.

**PALSUN® 3mm Breeze 70%LT**  
Solar Performance Graph (250-2,500nm)



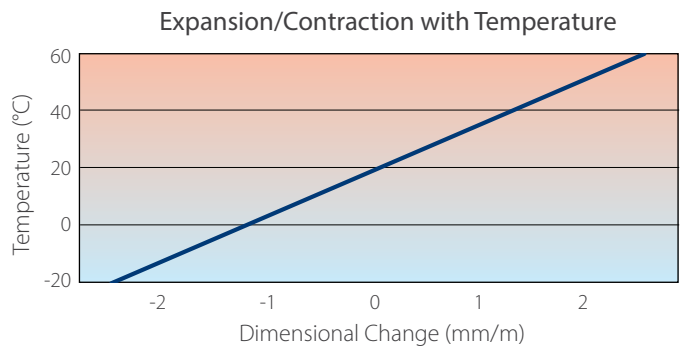
**PALSUN® 3mm Trans. Blue 68%LT**  
Solar Performance Graph (250-2,500nm)



## Thermal Characteristics

### Thermal Expansion

The thermal expansion of PALSUN sheets is higher than that of glass. This important factor must be taken into account when mounting the sheets. The graph on the right shows the degree of expansion/contraction as a function of temperature.



### Service Temperature

The temperature range over which the characteristics of PALSUN are retained extends from -50°C to +120°C (-60°F to +250°F) for short periods and from -50°C to +100°C (-60°F to +210°F) for long periods. This range of temperatures make PALSUN sheets suitable for use in most climates.

### Thermal Insulation

On very hot days, the surface temperature of the sheet might reach up to 60°C (140°F). The U-value characterizes the degree of thermal transmittance offered by a given glazing material, so higher U-values are associated with materials that are poor insulators and result in a greater loss of heat. The following table compares the U-values of glass and PALSUN sheets of equivalent thicknesses. Thicker sheets of a given material will offer greater thermal insulation and be characterized by a lower U-value and reduced heat loss. For any given thickness, the U-value of PALSUN sheet is lower than that of glass. This means that heat loss from the building interior, as well as penetration of heat or cold into a building, will be less if it were glazed with PALSUN than for one glazed with glass. This can result in a significant reduction in energy costs both for heating in winter and air-conditioning during the summer. Note that use of Solar Control sheets will insulate just as well, but will also reduce air-conditioning costs because of Near Infra-Red reflection and reduced heat buildup.

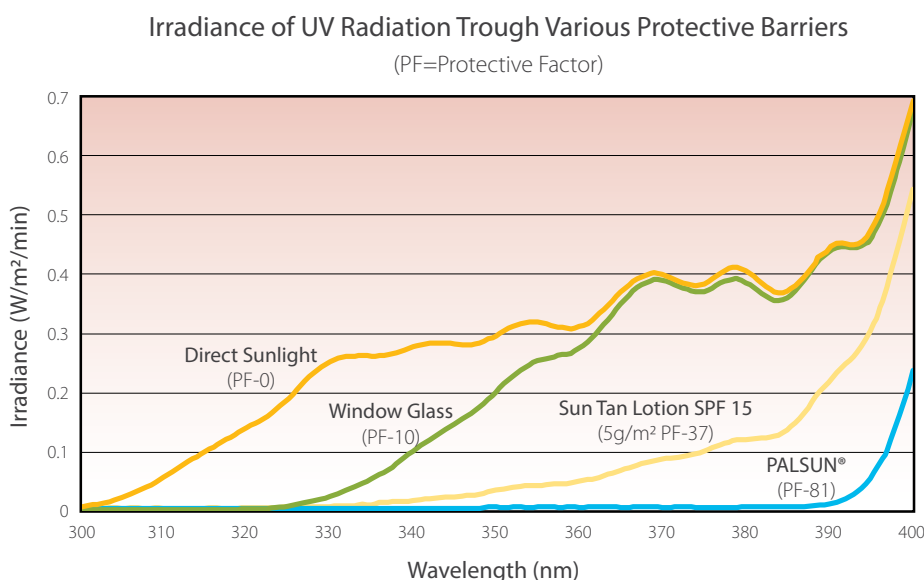
**Thermal Insulation of PALSUN® vs. Glass**

Thickness mm	Thickness in	PALSUN U-Value (W/m <sup>2</sup> ·K)	Glass U-Value (W/m <sup>2</sup> ·K)
3	(0.12)	5.47	5.81
5	(0.20)	5.19	5.72
6	(0.24)	5.07	5.68
8	(0.31)	4.48	5.60
10	(0.39)	4.63	5.52
12	(0.47)	4.43	5.45

## Protection from the Harmful Effects of UV Radiation

Exposure to solar ultraviolet (UV) radiation is widely known as a major health concern by now. The adverse affects were once thought to be associated with solar UV radiation in the 280-315nm (UV-B) range. However, in recent years it has become apparent that exposure to UV-A (315-400nm) is also detrimental. In addition to skin cancer, premature aging has been associated with exposure to UV-A. Both UV-A and UV-B portions of the UV spectrum are blocked out by PALSUN sheets. This screening of harmful UV radiation can be observed in the figure below.

A comparison of the UV protection offered by PALSUN and that offered by sunscreen is indicated in the graph on the right. Note that no barrier is as effective as PALSUN sheet. Activity below PALSUN will be more protected than that offered by proper application of sunscreen, though the latter is sufficient in almost all cases. The key word in the previous sentence is proper. Improperly applied sunscreen or forgetting to apply skin screen will result in undesirable levels of exposure. In addition, note that protection factors are computed on the basis of UV-B exposure. There is as yet no way to compute protection to UV-A exposure. It should also be noted that formulations that only block out UV-B are still being marketed. When playing or swimming below PALSUN, protection is always complete. When swimming, there is no danger that the protection will be washed away. In the last ten years, it has also been documented that UV exposure can also cause damage to the eyes, specifically to the cornea. Wearing sunglasses manufactured from polycarbonate protects the eyes. However, most people remove their glasses when entering the pool. This is a factor for both public and private pools to consider when contemplating a choice of covering.



## Acoustic Properties

Though only about half the weight of an equivalent glass panel, PALSUN glazing offers similar sound insulation properties along with much higher impact strength. These combined properties make PALSUN glazing the preferred material for see-through sound barriers: lightweight, easy to maintain or replace if necessary, highly transparent and vandal-proof.

The table on the right portrays the acoustic performance of PALSUN glazing versus glass.

Acoustic Insulation of PALSUN® Sheets According to EN 1793

Thickness mm	Sound Reduction dB
12	31
15	33

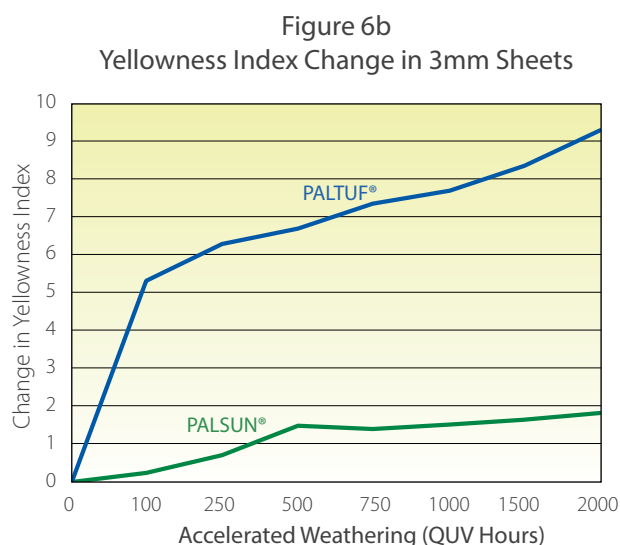
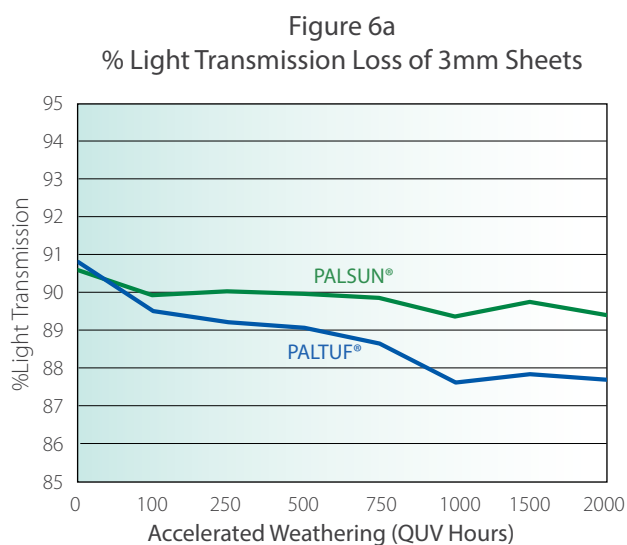
## Weather Resistance

Solar UV radiation attacks many polymeric materials. The rate of deterioration and crazing on the exterior surface will vary for different polymers. Further erosion is accelerated by water, dirt, air pollution, chemicals etc. The extent of attack depends on environmental factors such as location, altitude, local weather conditions, air pollution etc. The best initial indication is yellowing, followed by a significant reduction in light transmission and structural strength.

All PALSUN sheets (excluding those designated PALTUF, which are UV stabilized) are manufactured with a co-extruded, UV protective layer on one or two sides. This protective layer assures a long lifetime of service. PALSUN sheets retain their toughness and optical quality under intense UV exposure, with minimal reduction in their properties.

2000 hours of accelerated weathering (UV exposure, QUV - ASTM G154) tests, simulating 20 years of exposure in hot, sunny climates cause only a minor decrease in light transmission and a slight increase in yellowness Index for PALSUN. The changes in UV stabilized PALTUF sheet are greater.

The effect of QUV on 3 mm PALSUN & PALTUF sheets appears in the graphs below.



## Flammability

### General

As a thermoplastic, PALSUN eventually melts and burns under the intense heat of a blazing fire. However, PALSUN does not propagate flame, and is solidified and self-extinguished as soon as the direct flame is taken away. PALSUN doesn't produce any toxic fumes or gases when it burns.

### PALSUN® FR

PALSUN FR is a fire retardant flat solid polycarbonate sheet with improved flammability ratings. The flame retardant additives make it virtually non-combustible. When flame licks the sheet, it will only get scorched and eventually melt, solidifying quickly when the direct heat source is removed. Drippings do not ignite other combustible materials, as they do not actually burn.

### Smoke and heat extraction

In an actual, full-scale combustion, when PALSUN overhead glazing (as in skylights) is exposed to intense heat it will soften at 150°-160°C and produce apertures in the glazing, enabling heat and smoke to escape. Reduced temperatures inside the structure help to extinguish the fire.

## Flammability Classifications

PALSUN and PALSUN FR are classified as appears in the following table, based on tests executed by certified independent testing laboratories.

PALSUN®	
Standard	Classification*
EN 13501	B, s1, d0
NFP 92501, 4	M2 (1.5 to 12mm)
BS 476/7	Class 1y
UL-94	V2 (File e221255)
ASTM D-635	CC1

PALSUN® FR	
Standard	Classification*
UL-94	V-0

\* Depends on thickness. For additional information please contact your PALSUN distributor.

## General Recommendations for Working With PALSUN®

### Handling & Storage

1. PALSUN sheets should be transported and stored horizontally, on a flat, sturdy pallet whose dimensions are equal or larger than the largest of the sheets.

The sheets should be secured to the pallet during transportation and on-site handling. It is possible to stack the sheets with the longer sheets at the bottom and the shorter on top, leaving no unsupported overhang.

2. When moving a pallet with a forklift, always use forks as long as the sheets' width. Shorter forks used on a wider pallet may cause damage to the sheets.

3. PALSUN sheets leave the factory in packages, wrapped in white, watertight polyethylene. The wrapping should be removed as close to the actual time of installation (or use) as possible.

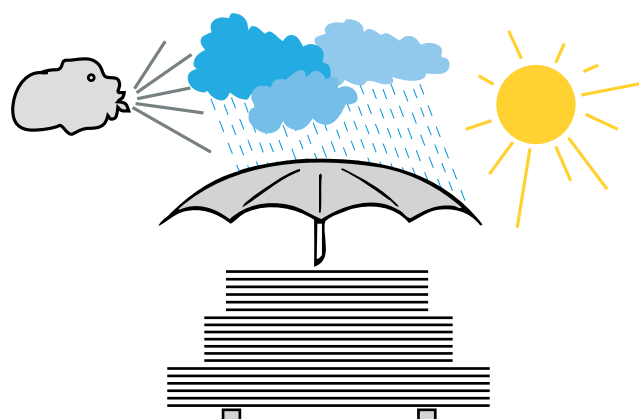
Storage of the sheets should be in a covered, dry, ventilated place, away from direct sunlight and rain.

4. Avoid extended exposure to direct sunlight, which may cause excessive heat buildup. Long term heating may lead to softening of the protective polyethylene masking, fusing it to the sheet's face and making removal difficult or even impossible.

5. Avoid leaving the sheets stored unwrapped. Dirt may accumulate on the sheets and/or their edges, attracted by electrostatic charges in the sheets, necessitating extra time and labor for cleaning before installation.

6. Whenever necessary to store the pallet in the open, cover it with white opaque polyethylene sheet, cardboard or any other insulating material, taking care to cover the stack completely.

Figure 7: Storing PALSUN® Sheets



# Determination of Required Sheet Dimensions

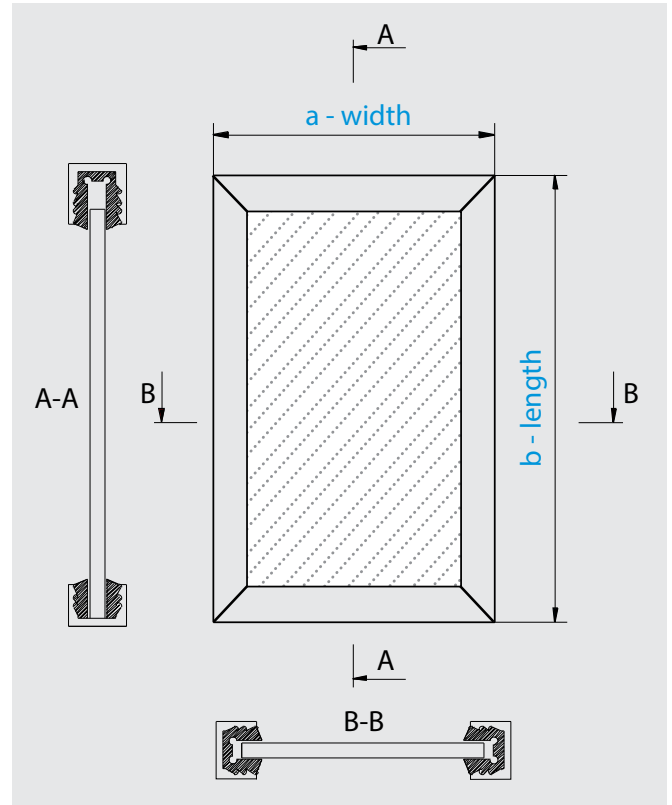
The information below is presented to assist in ordering the required dimensions.

## Determination of Sheet Size

Due to thermal expansion, PALSUN & PALTUF sheets have to be cut accurately at predetermined lengths smaller than the dimensions of the frame. At the end of the frame, clearance must be left for expansion. The following tables and diagram help calculate the required sheet dimensions. In addition, there is a table showing the expansion clearance necessary for various sizes of PALSUN & PALTUF sheets.

## Determination of Thickness

In order to determine the required thickness, the following table lists the sheet thickness required for a given wind load and width (at the narrow side of the sheet).



## PALSUN® Recommended Panel width

Wind/Snow Load Chart for Flat 4 Sides Clamped, Single Panel, Single Span

Thickness	Load (kg/m <sup>2</sup> )	Length / Width Ratio (b/a)				
		Ratio 1:1	Ratio 1.25:1	Ratio 1.5:1	Ratio 1.75:1	Ratio 2:1
4mm	50	985	875	820	795	785
	75	860	765	715	695	685
	100	780	695	650	630	620
	125	725	645	605	585	575
	150	685	605	570	550	540
	175	650	575	540	525	515
	200	620	550	515	500	490
5mm	50	1235	1090	1025	995	980
	75	1075	955	895	870	855
	100	980	865	815	790	775
	125	910	805	755	730	720
	150	855	755	710	690	680
	175	810	720	675	655	645
	200	775	685	645	625	615
6mm	50	1450	1300	1225	1200	1175
	75	1300	1150	1075	1050	1025
	100	1175	1025	975	950	925
	125	1090	965	910	885	865
	150	1025	910	850	830	815
	175	975	865	810	790	775
	200	925	825	775	755	740

PALSUN® Recommended Panel width - 4 sides clamped (Continued)

Thickness	Load kg/m <sup>2</sup>	Length / Width Ratio (b/a)				
		Ratio 1:1	Ratio 1.25:1	Ratio 1.5:1	Ratio 1.75:1	Ratio 2:1
8mm	50	1975	1750	1625	1590	1575
	75	1725	1525	1425	1390	1375
	100	1565	1390	1300	1270	1250
	125	1455	1290	1210	1180	1160
	150	1375	1210	1140	1110	1090
	175	1300	1150	1080	1050	1035
	200	1250	1100	1035	1005	990
10mm	50	2050	2050	2050	1990	1960
	75	2050	1910	1795	1740	1715
	100	1960	1735	1630	1580	1555
	125	1820	1610	1515	1465	1445
	150	1710	1515	1425	1380	1360
	175	1625	1440	1355	1310	1290
	200	1555	1375	1295	1255	1235
12mm	50	2050	2050	2050	2050	2050
	75	2050	2050	2050	2050	2050
	100	2050	2050	1955	1895	1870
	125	2050	1935	1815	1760	1735
	150	2050	1820	1710	1655	1630
	175	1950	1730	1625	1575	1550
	200	1865	1655	1555	1505	1480
14mm	50	2050	2050	2050	2050	2050
	75	2050	2050	2050	2050	2050
	100	2050	2050	2050	2050	2050
	125	2050	2050	2050	2050	2025
	150	2050	2050	2000	1930	1900
	175	2050	2000	1890	1835	1810
	200	2050	1925	1810	1755	1730
15mm	50	2050	2050	2050	2050	2050
	75	2050	2050	2050	2050	2050
	100	2050	2050	2050	2050	2050
	125	2050	2050	2050	2050	2050
	150	2050	2050	2050	2050	2025
	175	2050	2050	2025	1950	1925
	200	2050	2050	1925	1875	1850
18mm	50	2050	2050	2050	2050	2050
	75	2050	2050	2050	2050	2050
	100	2050	2050	2050	2050	2050
	125	2050	2050	2050	2050	2050
	150	2050	2050	2050	2050	2050
	175	2050	2050	2050	2050	2050
	200	2050	2050	2050	2050	2050

\* For wind load data in N/m<sup>2</sup> units, multiply value by 10 (e.g. 40 kg/m<sup>2</sup> = 400 N/m<sup>2</sup>).

Notes:

1. For 2 sides clamped installation please refer to the ratio 2:1 column.
2. The table is referring to various ratios of Length (b) and width (a) and valid for both Snow and wind load.
3. The table is referring to 4 sides clamped, flat installed Palsun panels.
4. Bedding depth shall be minimum 20mm.
5. The values are calculated according to deflection criterion of L/20 of the short span.
6. The table is not referring to self-weight deflections which might cause aesthetic issues.
7. The table is not referring to the sheet flexibility when vertically installed.
8. The data in the table refer to the short dimension, a.

**PALSUN® Recommended Panel Width for Curved Installation - Metric**

Maximum Recommended on Center Distance between Supporting Arches

Thickness	Sheet Curvature Radius	Maximum Recommended on Center Distance between Supporting Arches According to Wind/Snow Loads Below (mm)							
		Uniform Wind/Snow Loads (kg/m <sup>2</sup> )							
		50	80	100	120	150	200	250	300
4mm	700	2050	2050	2050	2050	2050	1900	1750	1600
	900	2050	2050	1850	1650	1500	1350	1200	1000
	1100	2050	1900	1750	1600	1450	1250	1050	900
	1300	1950	1800	1650	1480	1320	1180	1000	820
	1500	1800	1650	1500	1380	1200	1050	900	750
	1800	1650	1580	1420	1320	1120	950	820	700
	2000	1580	1480	1350	1250	1050	880	750	650
	2200	1500	1400	1300	1180	980	800	680	600
	2800	1350	1250	1180	1100	900	720	600	NA
	4000	1200	1050	950	850	780	650	450	NA
	6000	850	780	720	650	600	450	NA	NA
5mm	900	2050	2050	2050	2050	2050	2050	1900	1750
	1100	2050	2050	2050	2050	2050	1900	1750	1600
	1300	2050	2050	2050	2050	1950	1750	1600	1450
	1500	2050	2050	2050	1950	1850	1700	1550	1400
	1800	2050	2050	1950	1850	1750	1550	1350	1150
	2000	2050	1950	1850	1750	1550	1350	1150	1050
	2200	1950	1850	1750	1650	1500	1300	1100	1000
	2800	1600	1500	1400	1300	1200	1050	900	750
	4000	1400	1300	1200	1100	1000	850	750	600
6000	1200	1050	950	850	750	600	450	NA	
6mm	1100	2050	2050	2050	2050	2050	2000	1900	1750
	1300	2050	2050	2050	2050	2050	1900	1750	1600
	1500	2050	2050	2050	2050	1900	1750	1600	1450
	1800	2050	2050	2050	1950	1800	1650	1500	1350
	2000	2050	2050	1950	1850	1700	1550	1400	1250
	2200	2050	1950	1850	1750	1650	1500	1350	1200
	2800	1700	1600	1500	1400	1300	1150	1000	850
	4000	1600	1500	1400	1300	1150	1000	850	720
6000	1480	1380	1300	1200	1080	920	780	620	
8mm	1500	2050	2050	2050	2050	2050	1900	1750	1600
	1800	2050	2050	2050	2050	1950	1800	1650	1500
	2000	2050	2050	2050	2000	1900	1750	1600	1450
	2200	2050	2050	2050	1950	1850	1700	1550	1400
	2500	2050	2050	1920	1850	1720	1580	1420	1280
	2800	2050	1950	1820	1720	1600	1450	1300	1150
	4000	1950	1820	1720	1620	1500	1350	1200	1000
6000	1820	1680	1520	1380	1250	1100	950	780	
10mm	1800	2050	2050	2050	2050	2050	1950	1800	1650
	2200	2050	2050	2050	2050	2000	1850	1700	1550
	2800	2050	2050	2050	1950	1800	1750	1600	1450
	4000	2050	2050	2000	1900	1780	1620	1480	1320
	6000	2050	1920	1820	1720	1550	1400	1250	1100
12mm	2200	2050	2050	2050	2050	2050	2050	1950	1800
	2800	2050	2050	2050	2050	2050	1950	1800	1650
	4000	2050	2050	2050	2050	1950	1800	1650	1480
	6000	2050	2050	2050	1950	1720	1580	1420	1280

\* See notes on next page



PALSUN® Recommended Panel Width for Curved Installation - US Customary

Maximum Recommended on Center Distance between Supporting Arches

Thickness		Sheet Curvature Radius (mm)		Max. Recommended on Center Distance between Supporting Arches According to Wind/Snow Loads Below (in.)									
				Uniform Wind/Snow Loads (psf)									
In.	mm	In.	Ft.	10	15	20	25	30	40	50	60		
5/32"	4mm	28	2'-4"	81	81	81	81	81	75	69	63		
		36	3'	81	81	73	65	59	53	48	40		
		44	3'-8"	81	75	69	63	57	50	42	36		
		52	4'-4"	77	71	65	58	52	47	40	36		
		59	4'-11"	71	65	59	54	48	42	36	36		
		71	5'-11"	65	62	56	52	45	38	33	28		
		79	6'-7"	62	58	53	50	42	35	30	26		
		87	7'-3"	59	55	51	47	39	32	27	24		
		110	9'-2"	53	50	47	44	36	29	24	NA		
		158	13'-2"	48	42	38	34	31	26	18	NA		
236	19'-8"	34	31	29	26	24	18	NA	NA				
13/64"	5mm	36	3'	81	81	81	81	81	81	75	69		
		44	3'-8"	81	81	81	81	81	75	69	63		
		52	4'-4"	81	81	81	81	77	69	63	57		
		59	4'-11"	81	81	81	77	73	67	61	55		
		71	5'-11"	81	81	77	73	69	61	53	46		
		79	6'-7"	81	77	73	69	61	53	46	42		
		87	7'-3"	77	73	69	65	59	51	44	40		
		110	9'-2"	63	59	55	51	48	42	36	30		
		158	13'-2"	55	51	48	44	40	34	30	20		
		236	19'-8"	48	42	38	34	30	20	450	NA		
1/4"	6mm	44	3'-8"	81	81	81	81	81	79	75	69		
		52	4'-4"	81	81	81	81	81	75	69	63		
		59	4'-11"	81	81	81	81	75	69	63	57		
		71	5'-11"	81	81	81	77	71	65	59	53		
		79	6'-7"	81	81	77	73	67	61	55	50		
		87	7'-3"	81	77	73	69	65	59	53	48		
		110	9'-2"	67	63	59	55	51	46	40	34		
		158	13'-2"	63	59	55	51	46	40	34	29		
		236	19'-8"	58	54	51	48	43	37	31	21		
		5/16"	8mm	59	4'-11"	81	81	81	81	81	75	69	63
71	5'-11"			81	81	81	81	77	71	65	59		
79	6'-7"			81	81	81	79	75	69	63	57		
87	7'-3"			81	81	81	77	73	67	61	55		
98	8'-2"			81	81	76	73	68	62	56	50		
110	9'-2"			81	77	72	68	63	57	51	46		
158	13'-2"			77	72	68	64	59	53	48	40		
236	19'-8"			72	66	60	54	50	44	38	31		
13/32"	10mm			71	5'-11"	81	81	81	81	81	77	71	65
				87	7'-3"	81	81	81	81	79	73	67	61
		110	9'-2"	81	81	81	77	71	69	63	57		
		158	13'-2"	81	81	79	75	70	64	58	52		
		236	19'-8"	81	76	72	68	61	55	50	44		
1/2"	12mm	87	7'-3"	81	81	81	81	81	81	77	71		
		110	9'-2"	81	81	81	81	81	77	71	65		
		158	13'-2"	81	81	81	81	77	71	65	58		
		236	19'-8"	81	81	81	77	68	62	56	51		

Notes for Tables "PALSUN® Recommended Panel Width for Curved Installation":

1. PALSUN glazing sheets should be installed with their curved edges sustained on the supporting arches, with 15 to 25mm (5/8" to 1") edge engagement, depending on the span, in addition to a thermal expansion gap of 2-3mm (3/32" - 1/8").
2. Thin sheets up to 6mm (1/4") can be bent as relatively short glazing panels, 2m to 3m at 1000 to 1220mm width (6'7" to 10' length, at 40" to 48" width). Thick 8mm sheets (5/16") and above can be cold curved only as special long panels 4m to 7m (13' 2" to 23'), particularly when full width of 2050mm (6' 9") or similar is installed.
3. Supporting arches and clamps should withstand total maximum permitted loads without difficulty.
4. Spans under 500mm (20") are generally impractical for an installation method of this type.
5. The lowest radius value indicated is the minimal permitted radius for that specific PALSUN sheet.
6. Indicated spans are suitable for most common stationary structures, under pressure or uplift loads. Special structures, like mobile pool covers, may use wider spans, subject to preceding approval.

# Installation

## Choice of the Frame

PALSUN & PALTUF sheets can be mounted in most existing frames made of wood, rigid PVC, aluminum or other metals. It is recommended to use neoprene or EPDM packing (never use soft PVC) to secure the sheet in its frame, rather than fixing with screws. Butyl rubber sealing strip or silicone sealant (PALRAM has tested and recommends Dow Corning Q3-7098 or Q3-3793 and Novasil S 64) are also permissible. For a list of compatible adhesives and sealants see Palram "Recommended Adhesives and Sealants for Polycarbonate Sheets".

## Adjusting The Sheet to Frame Dimensions

("c" and "d" refer to the indicated dimension in the diagram shown below).

If sash dimension "c" or "d" is:	Trim sheet by:
300 mm (11.8 in.)	1 mm (0.04 in.)
300 mm (11.8 in.) - 700 mm (27.6 in.)	2 mm (0.08 in.)
700 mm (27.6 in.) - 1000 mm (39.4 in.)	3 mm (0.12 in.)
1000 mm (39.4 in.) - 1300 mm (51.2 in.)	4 mm (0.16 in.)
1300 mm (51.2 in.) - 1700 mm (66.9 in.)	5 mm (0.20 in.)
1700 mm (66.9 in.) - 2000 mm (78.7 in.)	6 mm (0.24 in.)
2000 mm (78.7 in.) - 2300 mm (90.6 in.)	7 mm (0.28 in.)
2300 mm (90.6 in.) - 2700 mm (106 in.)	8 mm (0.31 in.)
2700 mm (106 in.) - 3000 mm (118 in.)	9 mm (0.35 in.)

Sheet Thickness Required for Given Sheet Width\* and Rabbet Depth. ("a" and "e" refer to the indicated dimensions in the diagram shown below).

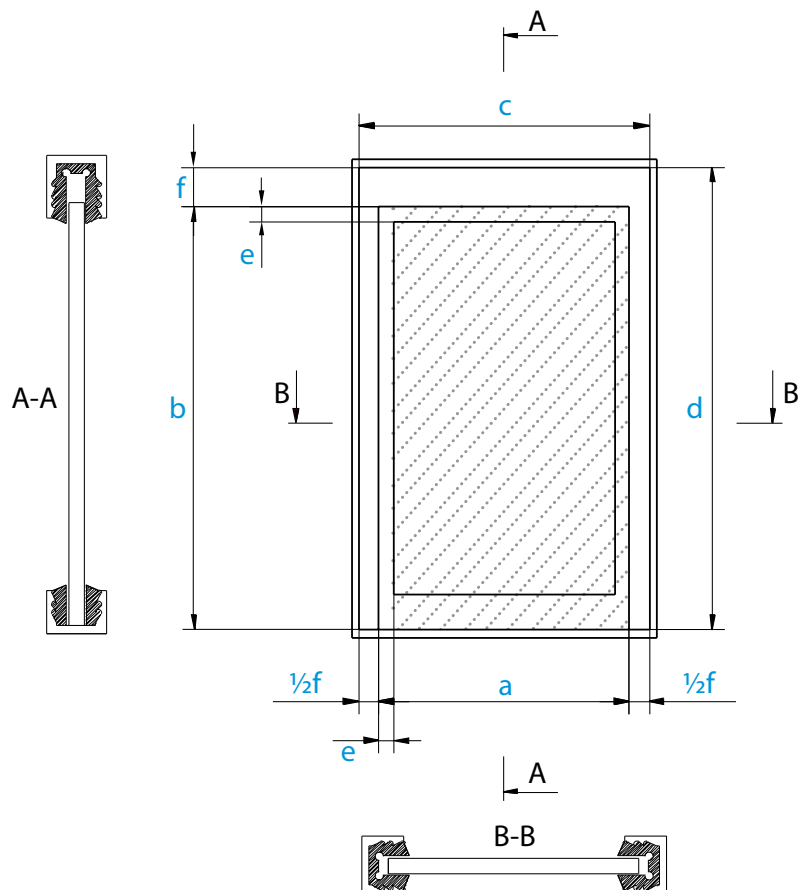
Width* (a)	Thickness	Rabbet Depth (e)
700 mm (28 in.)	3 mm (0.12 in.)	15-20 mm (0.6 - 0.8 in.)
900 mm (35 in.)	4 mm (0.16 in.)	15-20 mm (0.6 - 0.8 in.)
1100 mm (43 in.)	5 mm (0.20 in.)	15-20 mm (0.6 - 0.8 in.)
1300 mm (51 in.)	6 mm (0.24 in.)	20-30 mm (0.8 - 1.2 in.)
1500 mm (59 in.)	8 mm (0.31 in.)	20-30 mm (0.8 - 1.2 in.)
1700 mm (67 in.)	10 mm (0.39 in.)	20-30 mm (0.8 - 1.2 in.)
1900 mm (75 in.)	12 mm (0.47 in.)	20-30 mm (0.8 - 1.2 in.)

\*Width refers to the smaller dimension.

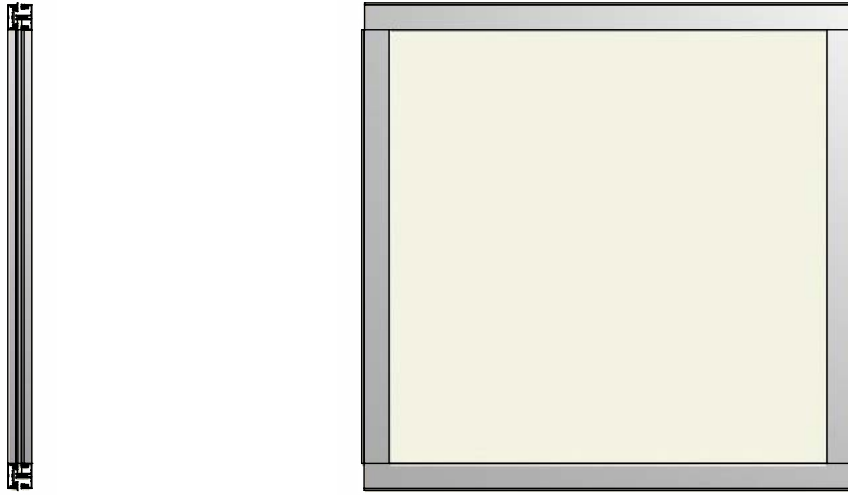
## Example Frame

### Legend

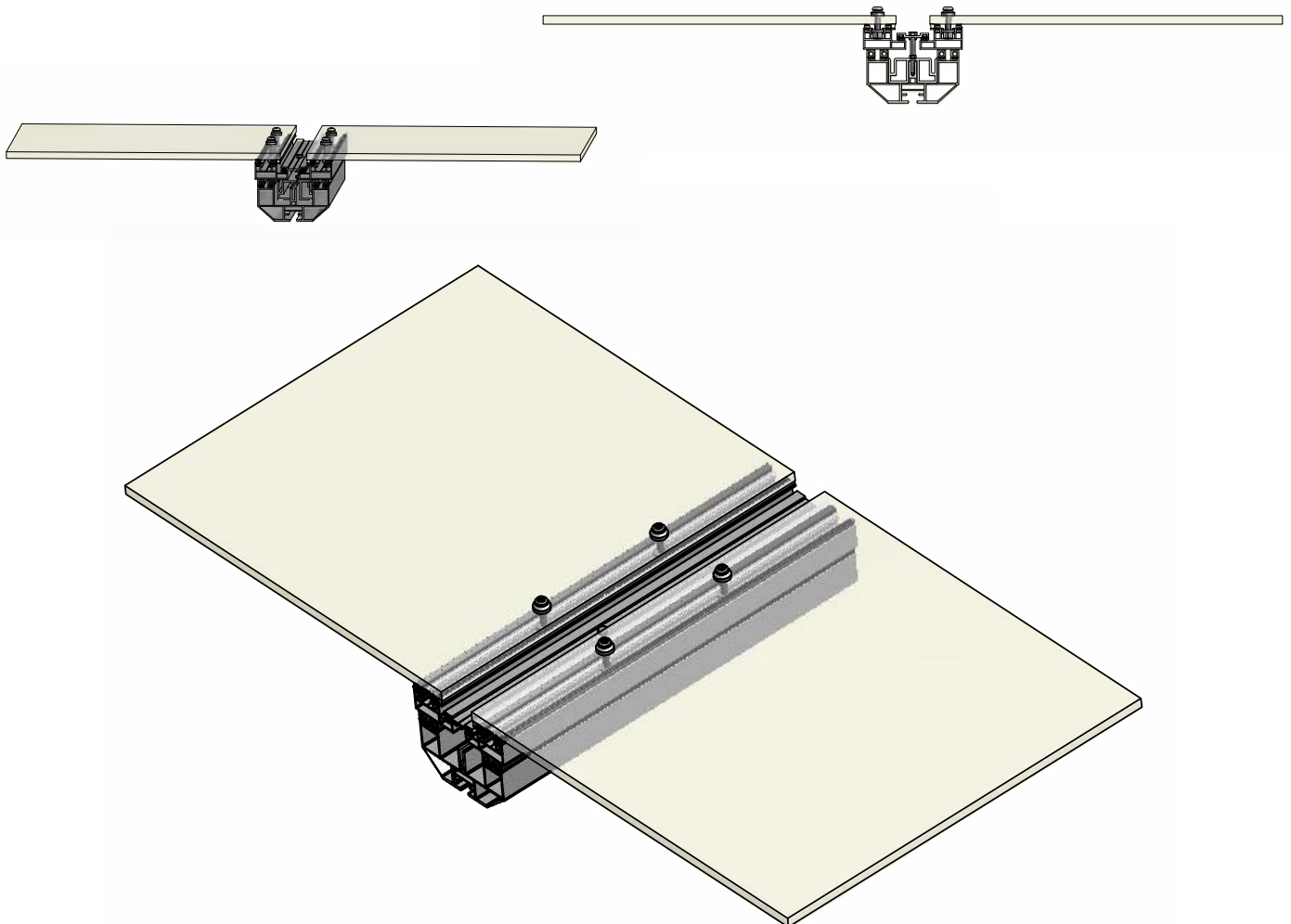
- a ... Sheet width
- b ... Sheet length
- c ... Sash width
- d ... Sash length
- e ... Edge engagement
- f ... Thermal expansion allowance
- g ... Rabbet depth =  $\frac{1}{2}f + e$



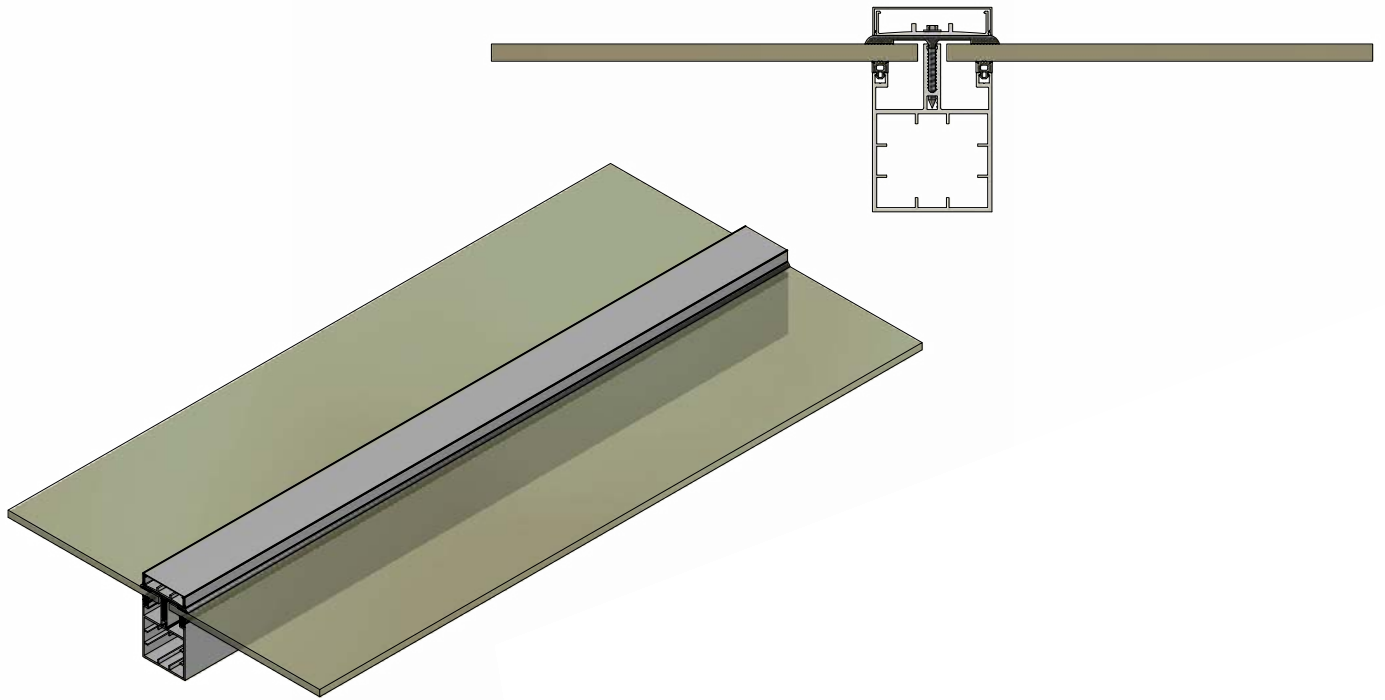
PALSUN® Glazing



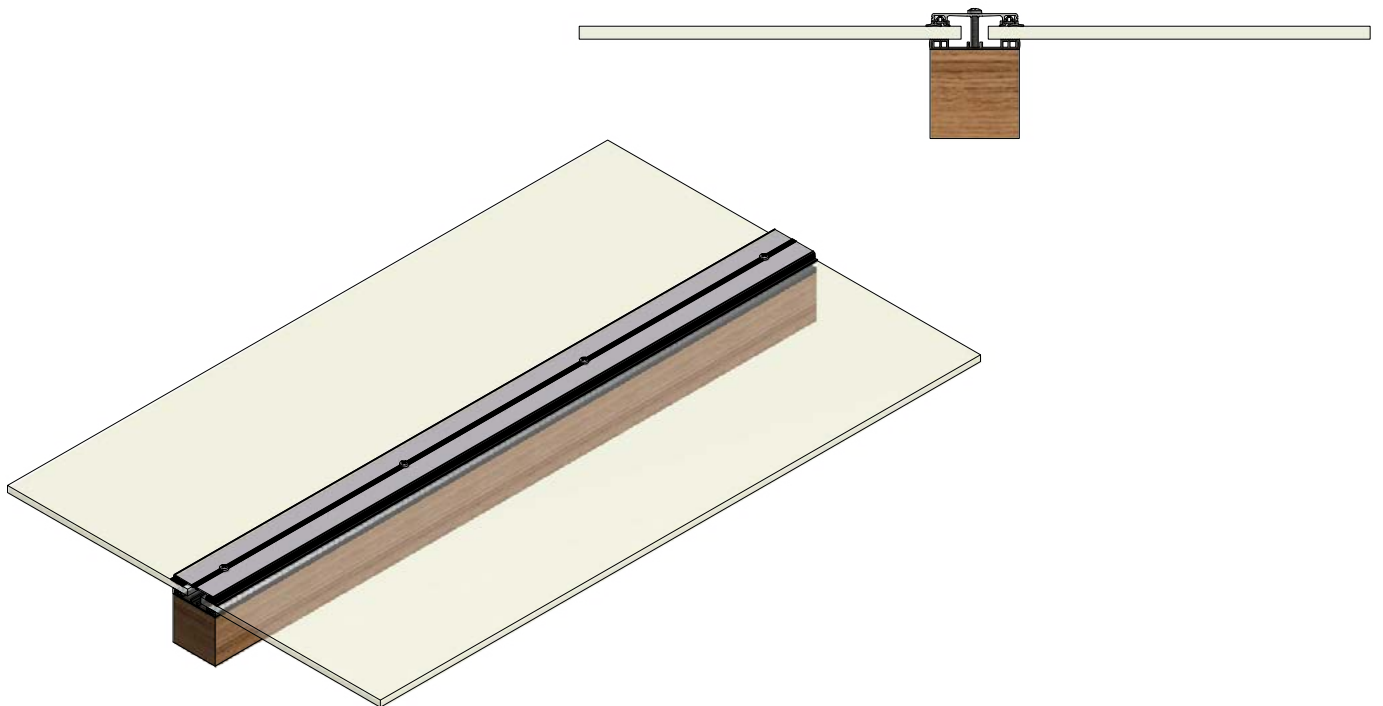
GA-2004 Glazing Detail



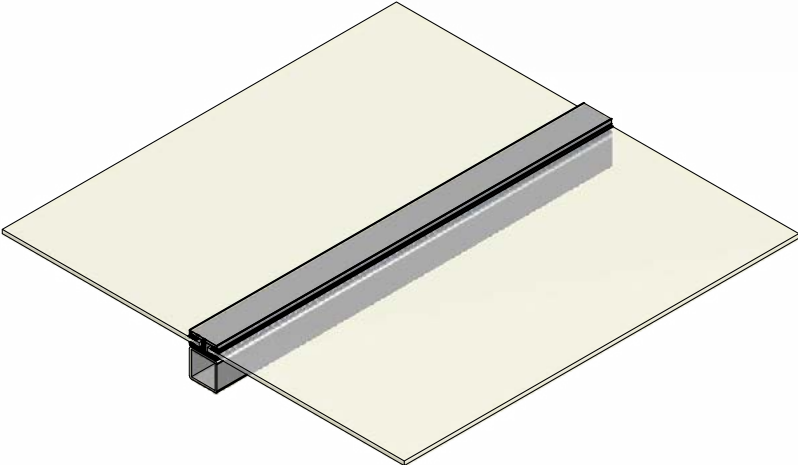
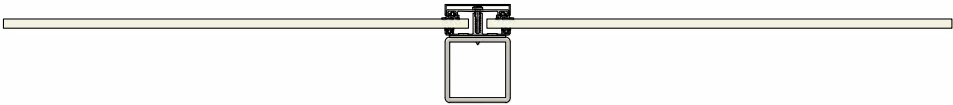
## Glazing System Detail



## Hybrid Glazing System Detail

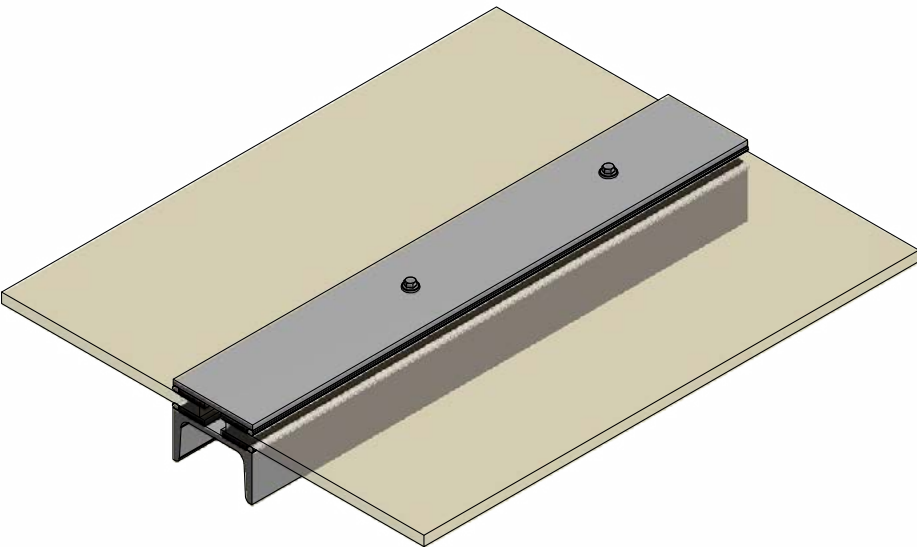
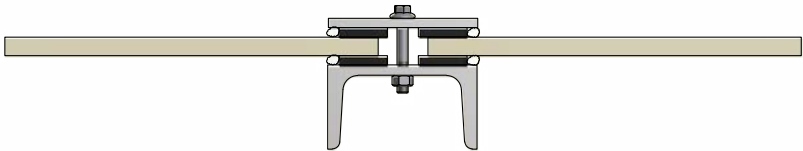


Oriented Glazing System Detail

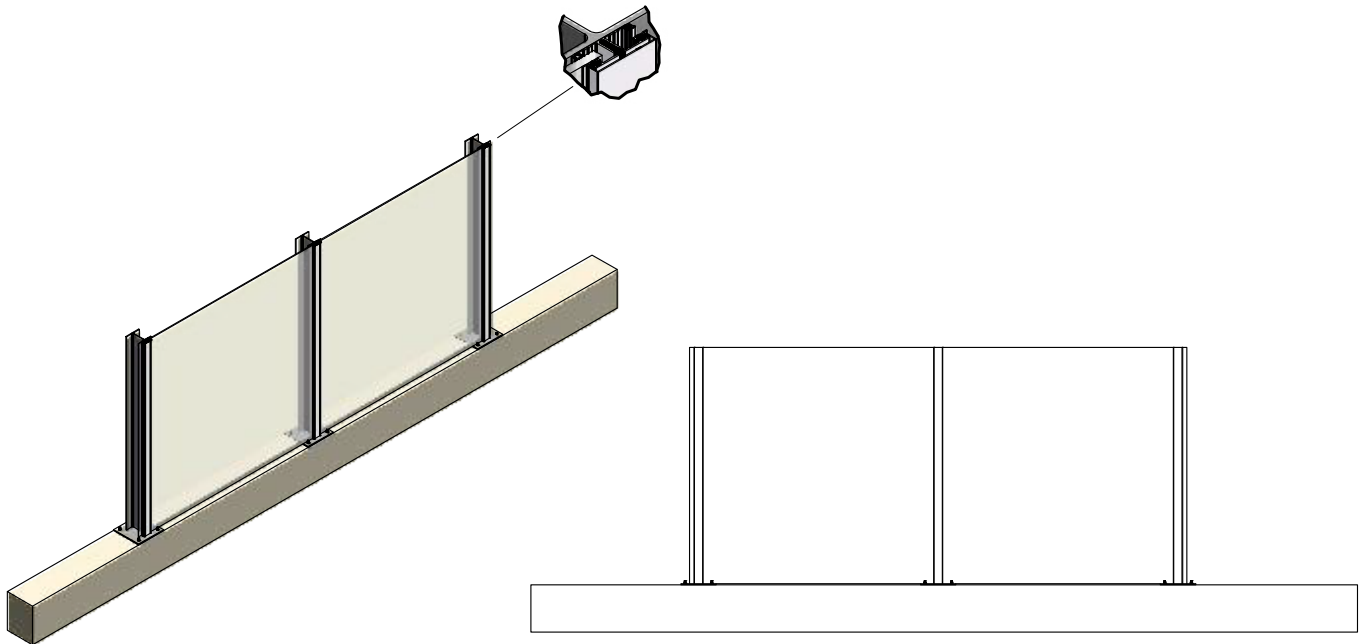


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Wet Glazing Detail



## Glazing System Detail



## Mechanical Fastening

PALSUN & PALTUF sheets can be fastened with nuts and bolts, providing that several points be kept in mind:

- Never use rivets, as they apply excessive force and could cause cracks in the sheets.
- Always drill a slightly over-sized hole by 2-3mm ( $\frac{3}{32}$ " -  $\frac{1}{8}$ ") to compensate for thermal expansion.
- Never use soft PVC washers!
- Use neoprene and aluminum washers to distribute the load.
- When using mechanical fasteners, they should be evenly spaced to avoid stress accumulation at particular points.
- With nuts and bolts, tighten moderately and use only rust-free materials.
- Wherever possible, a "floating sheet in frame" is preferable, similar to glass, and without mechanical drilled fasteners.

### Treatment of Sheets after Installation

The sheet's polyethylene masking must be removed after it is installed. The masking covers the sheet to protect it during handling, storage, and installation, but once the sheet is installed - **it must be removed within 24 hours**.

A non-standard masking that can be left on the sheets for up to one month and then removed immediately is available upon special request and is subject to a minimum quantity order.

PALSUN & PALTUF sheets may be cleaned by carefully following the [instructions on page 30](#).

## General Fabrication Guidelines

### Tools

PALSUN sheets can be fabricated with standard power or hand tools for wood or metal, as long as they are well sharpened and have the clearance required for machining rigid plastics. Only speed regulated tools should be used. The highest possible speed that will not melt the sheet during processing, due to the heat buildup, will achieve the best results.

High-Speed steel tools are adequate in most cases. Carbide-tipped tools are preferred for continuous production lines.

Tools should be set up so just the cutting edges should come into actual contact with the fabricated material, to reduce frictional heat buildup.

### Cooling

- Cooling is not required under standard machining conditions.
- When high-speed machining is necessary, clean water or compressed air can be used to cool the material and tool, and remove the machining chips.
- Never use cooling oil or emulsions, as they may damage the PALSUN sheet.
- In order to avoid induced internal stresses generated by overheating, care must be taken to keep heat buildup to absolute minimum.

### Size Regulation

Due to the high thermal expansion rate of PALSUN, which is considerably greater than that of metals, glass or concrete, precision measurement checks should always be done at a fixed reference ambient temperature.

### Protective Film (Masking)

The PALSUN polyethylene (PE) protective masking may be left on the sheet during most regular fabrication, to prevent damage to the surface.

### Fabrication Markings

When necessary, mark sheets to be fabricated on the protective masking. If, for some reason, it is necessary to mark directly on the sheet, use wax pencils or felt tipped marking pens.

Marking the exposed surface by scratch marks with sharp objects may initiate fractures and induce failure under load.

## Sawing & Cutting

A variety of power saws, either table mounted or portable can be used to saw PALSUN. Shearing or punching are also possible. Laser or water-jet cutting are less common but also possible techniques.

### Table Mounted or Portable Circular Saws

These types of saw are widely used to saw PALSUN. There are two major workshop types and one portable type:

- A Moving Table, Fixed Blade Bench Saw: is preferable for long, straight sawing.
- Radial Arm Saw: is generally used for "cross-cut" (width) or diagonal sawing.
- Portable Circular Saw: usually restricted for use on site for straight cutting, is slower and not as accurate as table saws. This type of saw may be attached underneath a special bench to function as an on-site, limited operation fixed table saw.

### Circular Saw Blades

Should be fine toothed hollow ground, or preferably carbide tipped, triple chipped or alternate bevels (Alt 1 and Alt 2, see figures 9a & 9b on next page, respectively), with minimal blade body contact with the cut material. Such blades can offer clean, good quality cuts.

## Generally Accepted Recommendations for Circular Blade Specifications

Property	Units	Sign	Value
Clearance angle		$\alpha$	10 – 20°
Rake angle		$\gamma$	5 – 15°
Alternate double-bevel angle (Alt. 1)		$\alpha^\circ$	45°
Alternate bevel angle (Alt. 2)		$\beta^\circ$	10 – 15°
Cutting speed -	m/min. (ft/min)		1,000 - 3,000 (3,300 - 10,000)
Rate of feed	mm/sec. (inch/sec.)		30 ( <sup>11</sup> / <sub>4</sub> )
Thin gauge: 1.5-2.5 mm tooth pitch ( <sup>1</sup> / <sub>16</sub> " - <sup>3</sup> / <sub>36</sub> " )	Teeth per mm (Teeth per inch)	t	2.5 - 6 (10 - 12)
Heavy gauge: 3.2 - 12 mm tooth pitch ( <sup>1</sup> / <sub>8</sub> " - <sup>1</sup> / <sub>2</sub> " )	Teeth per mm (Teeth per inch)	t	6.5 - 8.5 (3 - 4)

- Notes:
- 2 Possible alternatives (Alt 1 & Alt 2, see figures 9a & 9b below) are supplied by different tools manufacturers as alternate beveled teeth for blades intended for cutting plastics, and both offer satisfactory cuts (line 3 in the table).
  2. For sawing thin gauge sheets of less than 2mm thickness, It is recommended to batch together 10 - 15 such sheets, with a thicker (3-4mm) bottom sheet for support.
  3. Shearing is the preferable option for cutting a single thin gauge sheet.

### Palram Particular Circular Saw Cutting Recommendations

These recommendations are based on technical know-how, particular tests and vast practical experience accumulated during years of work. These recommendations are to be accepted only as general guidelines.

Figure 8: Typical Circular Saw Blade (segment)

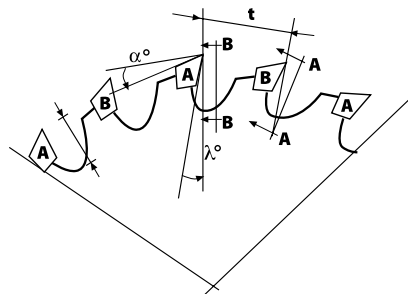


Figure 9a: ALT1 - Alternate Teeth Configuration

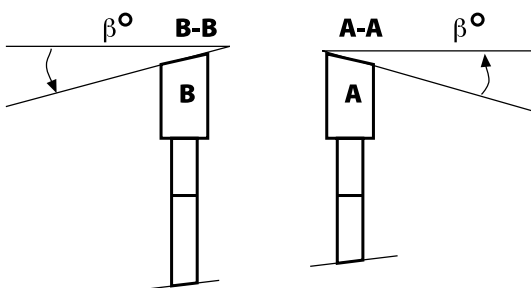
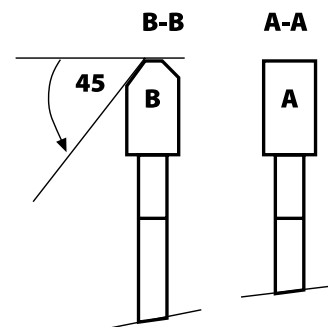



Figure 9b: ALT2 - Alternate Teeth Configuration






### Saw Blade Specifications for Cutting PALSUN up to 5mm Thickness

Property	Units	Value
Clearance angle	mm (inch)	300 (12)
No. of teeth in blade		96
Thickness	mm (inch)	2.2 - 3.2 ( $\frac{3}{32}$ " - $\frac{1}{8}$ " )
Teeth angles		Rake: 45° Clearance: 15° Alternating: Left - Right
Tooth appearance		
Speed	rpm	1800 - 2400

### Saw Blade Specifications for Cutting PALSUN 6mm Thickness and Above

Property	Units	Value
Clearance angle	mm (inch)	350 (14)
No. of teeth in blade		108
Thickness	mm (inch)	2.2 - 3.2 ( $\frac{3}{32}$ " - $\frac{1}{8}$ " )
Teeth angles		Rake: 10° Clearance: 15° Alternating: Left - Right
Tooth appearance		
Speed	rpm	1800 - 2400

- Notes:
1. Teeth shapes sketches are not to scale. They should be considered to serve only as an indication.
  2. The PALSUN should be placed on a firm flat base and clamped into position during sawing.
  3. When sawing PALSUN, it is recommended to leave the protective masking on.
  4. If the cut sheet vibrates during sawing, cardboard sheet padding may be placed beneath it to absorb the vibrations.
  5. When sawing thin gauge PALSUN it is recommended not to cut single sheets by themselves, but saw a pack of 5-10 sheets at the time, clamped firmly together to a steady base.
  6. Low to moderate feed rate should be used when the sheets approach the blade, or vice versa. A feed rate that is too high can cause gumming, splitting or breaking of the sheet edges.

### Band Saw

Band saws can be used for cutting PALSUN sheets of most thicknesses with acceptable results. Band saws are workshop tools. In PALSUN fabrication they are mostly used to cut formed parts or irregular shapes. It is possible to cut flat sheets in straight lines too, but in limited length and width, due to the tool's limitations.

- Thin gauge sheets are better sawed when stacked to a thickness of 10 -12 mm (0.4 - 0.5 in.)
- The preferred band saw blade should have slightly set teeth, with 10 – 20 mm (0.4" - 0.8" inch) blade widths.

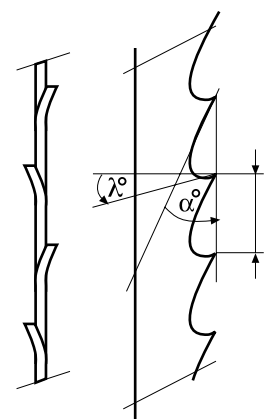


Figure 10: Typical Band Saw Blade Configuration

## Recommended Band Saw blade Properties

Property	Sign	Units	Value
Clearance angle	$\alpha$		10 – 20°
Rake angle	$\gamma$		5 – 15°
Cutting speed		m/min (ft/min)	1,000 - 6,000 (1,950 - 3,300)
Rate of feed		mm/sec (inch/sec)	20 ( <sup>13</sup> / <sub>6</sub> )
Thin gauge: 1.5-2.5 mm tooth pitch ( <sup>1</sup> / <sub>16</sub> " - <sup>3</sup> / <sub>36</sub> " )	t	Teeth per mm (Teeth per in.)	1.5 - 2.0 (12 - 18)
Heavy gauge: 3.2 - 12 mm tooth pitch ( <sup>1</sup> / <sub>8</sub> " - <sup>1</sup> / <sub>2</sub> " )	t	Teeth per mm (Teeth per in.)	2.5 - 3.5 (7 - 10)

### Notes:

1. A band saw is suitable for cutting curved lines and 3-dimensional, formed parts.
2. For cutting a few formed objects of the same shape, they must be firmly clamped together.
3. A band saw cutting usually yields rougher finished edge, which must be smoothed by sanding and polishing. An endless belt sander is a preferred tool for such an operation.
4. Palram recommends using a circular saw for better-finished edges, whenever possible.

## Portables: Jigsaw or Saber Saw

Portable saws of these types use short movement, reciprocating blades, instead of one-direction orientation, continuous movement blades like those of circular or band saws, and are much slower in operation.

- **Chipping:** Various sized chips are broken off on both edges of the sawing line, leaving the cut edges rough and uneven.
- **Gumming:** Chips and splinters from the advancing saw blade overheat during the sawing process, melt and create a mass of cooled down material in front of the blade and on both sides of the cut. The swarf sticks to the edges, leaving an unsightly, rough edge finish, which would be difficult to clean.

Jigsaw or saber saw cutting usually results in an inferior finish of the cut edges, worse than the results achieved by a circular saw. Palram recommends sanding and polishing of the cut edges as standard practice. An endless belt sander is the preferred tool for such an operation.

Gummed material may also stick to the blade itself and cause seizure.

The same uncontrolled heat that creates gumming may also induce undue internal stresses along the edges of the cut, necessitating cooling of the sheet.

### Recommended Remedies:

- Choose the correct tooth size and pitch.
- Select a more appropriate saw speed.
- Lower the feed rate.
- Examine the sharpness of the blade.
- Examine the blade alignment.
- Cool the blade with compressed air when long cuts are required.
- Take frequent pauses during long production runs, to let the saw blade cool down.
- Begin sawing with the blade already running at the full recommended speed.

## Routing

A versatile technique, enabling diversity of edge fabrications and trimming of PALSUN sheets, notably for parts too large or of irregular shape for a band saw. With sharp two-flute straight cutters, this technique can produce very smooth edges.

- The feed rate should be slow, to avoid excessive heat buildup and shattering.
- As a safety measure, when routing, always guide the sheet with a suitable jig.
- A jet of compressed air can be used to cool the bit and the sheet at the spot of cutting and assist in chip removal.

**Static bench routers:** Fast, strong and stable, for complex and accurate straight-line fabrications.

**Portable routers:** Less powerful, for smaller or on site jobs. Also used for trimming and edge fabrications of irregular shapes. Can perform certain small milling jobs like butt shaping on rectangular or round apertures or tongue and groove butt finish on thicker sheets.

### Applications - Primary Edge Finishing

- Quick and accurate trimming or finishing of straight-edged or curved cut PALSUN sheets.
- Easily produced straightedge corners or curved butts.
- Preparation of varied lap and butt joint fabrications.

### Applications - Tooling

- **Routers:** Universal, commercially available equipment.
- **Routing cutters:** new metalworking cutters, kept at utmost sharpness.

### Recommended Band Saw blade Properties

Property	Units	Value
Clearance angle		5 - 10°
Rake angle		0 - 10°
Router speed - w/o load	rpm	15,000 - 22,000
Cutting speed	m/min. (ft./min.)	100 - 500 (330 - 1640)
Feed rate	mm/rev. (inch/rev.)	0.1 - 0.5 (0.004 - 0.07)

Routing and milling tips For clean, smooth routing work ensure cutter's sharpness and faultless alignment before starting work. Compressed air jet cooling following the cutting head improves the culter's speed, cut quality and blows the swarf away. Let the tool reach its maximum (unloaded) operating speed before commencing work.

### Milling & Joining

A portable router, with suitable cutters, can be used for small milling jobs.

A standard woodworking jointer-planer, preferably with carbide or high-speed blades/cutters, can be used for trimming, resulting in a good quality edge finish.

Avoid excessive stock removal, which may result in shattering or rough edges. A cut of 0.4 mm (0.016 in.) or less per pass is recommended.

### Finishing Recommendations for Well Done Sawing and Cutting

Unintended saw marks, rough or jagged corners, or uneven, drawn edges created by imperfect shearing may result in crazing and cracking, that can develop further to failure under load.

Palram recommends finishing the edges of cut PALSUN sheets by finishing the edges to a smooth appearance.

This will ensure that no cracks will develop from the irregularities at the edges.

Smoothing techniques are discussed in ["Finishing" Section on page 29](#).

# Drilling

## General Indications

**Drill bits:** Regular, new high-speed steel twist drills, or new carbide-tipped drills are suitable for drilling holes in PALSUN sheets of various thicknesses, as long as they are sharpened well. They are used mainly for bores up to 12 mm(1/2") diameter.

Figure 14a: Regular Drill Bit

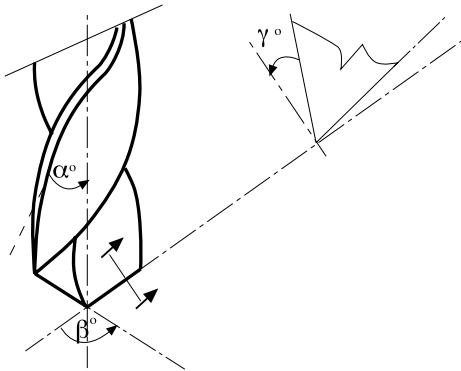
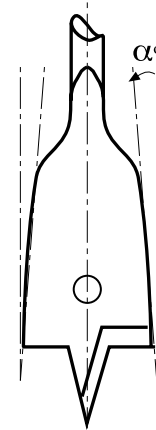


Figure 14b: Flat Chisel Edged Drill Blade



Larger holes may be drilled by flat, chisel edged drill blades with a triangular cutting tip, similar to those used in woodworking, kept always very sharp. Rake angle should be about 5° to avoid side friction. They are used mainly for bores from 12 to 20mm (1/2" to 13/16"). Commercially available cutting cups or circle cutters of several types can be used for performing large round apertures.

**Speed:** Decrease the drill's speed as hole diameter and / or sheet thickness gets larger. Drilling speed may vary due to actual conditions.

**Feed rate:** May vary due to actual conditions.

### Drilling Speed and Feed Rate Change in Accordance with Bore Diameter

Hole Diameter			Drill Speed	Feed Rate	
mm	Inch 1	Inch 2	rpm	mm/rev	inch/rev
3	1/8	0.12	1500 - 1800	0.03 - 0.07	0.012 - 0.028
6	1/4	0.24	800 - 1500	0.03 - 0.07	0.012 - 0.028
10	13/32	0.4	500 - 1000	0.01 - 0.07	0.004 - 0.028
15	19/32	0.6	350 - 700	0.07	0.028
20	25/32	0.8	250 - 350	0.07	0.028

### Recommended Drill Bit Configurations

Property	Sign	Units	Value
Clearance angle			10 – 20°
Rake angle	$\gamma^\circ$		0 – 10°
Drill tip angle	$\beta^\circ$		110 – 150°
Helix angle	$\alpha^\circ$		30°
Cutting velocity		m/min. (ft./min.)	15 - 30 (49 - 98)

Notes: For small gauge sheets (1 - 2 mm or 0.04 - 0.08 in.) we recommend using flatter tip drill bits ( $\beta = 140 - 150^\circ$ ) for achieving a cleaner bore with less risk of chipping.

## Drilling tips and recommendations

- **Location:** Locate holes no closer to the edges than 2 – 2.5 times the diameter of the pertinent hole, with a 10mm (0.4 inch) minimum.
- **Precision:** It is imperative to keep the sheet (or stack of sheets) firmly clamped to a stable workbench (or a similar base) to avoid fluttering during drilling.
- **Cooling:** Usually cooling is not required with regular drills.  
However, in cases of deep drilling, like putting perpendicular holes through the sheet's edge, or when drilling through a stack of sheets, cooling both the drill bit and the vicinity of the hole with a jet of compressed air is a good practice.  
It is also recommended, when drilling deep holes, to stop frequently, pull the drill out and clear the hole from swarf and debris with compressed air.
- **Preventing internal stresses:** Producing a clean, smooth bore, keeping heat buildup to the minimum, by the procedure described above, prevents excessive heat buildup, meltdown and gumming of the drilling dust and debris, and possible seizure of the bit. It also prevents undue internal stresses at the vicinity of the hole.
- Honing and polishing the edge of the hole by mechanical or chemical means contributes to keeping the sheet stress-free, preventing cracking.
- **Maintaining the edge:** Carbide tipped twist drill bits are preferable for long or continuous production runs. They are more durable and improve the edge quality.

## Finishing

### General Comments

#### Reasons, Means and Targets

The final step in fabrication, finishing improves both the practical and aesthetic properties of PALSUN sheet prior to assembly.

#### Grinding & Polishing

This is mostly done as a part of edge preparation.

**Practical objective:** Rough, uneven, untended edges may be starting points for crazing and cracks after the PALSUN sheet is installed and subjected to day by day exposure to wind loads, UV radiation and thermal expansion & contraction, not to mention man-made impacts.

**Aesthetic objective:** Nicely finished, smooth edges are a must for a quality appearance of the finished product, often installed with exposed edges.

**Decorating:** A type of finishing intended mostly for aesthetic appearance or for display purposes. Executed by painting, printing, films or hot stamping.

### Grinding / Sanding

#### General

A primary stage in edge finishing, rough or jagged edges and cutting tool marks created by a saw, shearing machine or a router, can be removed by grinding.

#### Grinding / Sanding Recommendations

A belt sander, equipped with a 400-500 grit belt, running at 20 - 30 m/sec (65 - 100 ft./sec), is the preferred option, applying low contact pressure during operation. Wet sanding and waterproof belts are preferable, as they prevents heat buildup, sanding dust accumulation, and prolong sanding belt life.

A reciprocating or orbital sander can also be used, but it can be applied only by the dry sanding method.

Manual Sanding can also be used, wet or dry, working with successive grit size abrasive paper (Starting with 100, then 280-grit silicon-carbide, and finally 400-600 grit sandpaper).

# Cleaning

## General Polycarbonate Cleaning Guidelines

- Never use abrasive or high alkaline cleaners on PALSUN sheets.
- Do not use cleaners on PALSUN sheets for an extended period of time. Rinse immediately with clean, cold water.
- Do not apply cleaners in direct sunlight.
- Never use sharp objects, wipers (squeegees) or razors on PALSUN sheets.
- Do not clean with gasoline.
- Always practice safety first and never step directly on PALSUN sheets.
- Always test cleaners in a small inconspicuous area prior to cleaning entire panel to prevent adverse results.
- When using a pressure washer, do not allow the spray tip to come too close to the panel, as it could have enough pressure to penetrate or tear the panel.
- Avoid dry cleaning, as sand and dust particles clinging to the exterior of the panels may scratch the surface.

## General Cleaning Instructions for Products

The Palram polycarbonate products can be easily cleaned utilizing a soft sponge or cloth made from 100% cotton, lukewarm water and a mild dish washing detergent. All surfaces should then be rinsed with cold water and dried with a soft cotton cloth to reduce water spotting. In some instances this procedure may be inadequate and require the use of additional cleaning agents. The agents listed below have all been approved for use at room temperature.

## Cold Forming

### Cold Curving

1. PALSUN sheets can be cold bent or curved, within their minimal permitted bending radius, without damaging their mechanical performance. The minimal permitted bending radius for a PALSUN sheet is a factor of their thickness and should be calculated in the following manner:  $200 \times \text{sheet thickness}$  (e.g. for a 5mm PALSUN sheet,  $5 \times 200 = 1000\text{mm}$  minimum cold bending radius). Moreover, based on our experience and observations, the internal stresses induced by curving give them extra strength and rigidity in both directions, as in pre-stressed concrete elements.
2. Rigidity and support spans increase progressively as the curve radius is reduced (down to the minimal permitted radius). A shallow curve should be considered virtually the same as a flat panel, while a deep curve may add significantly to the bridging ability.

### Brake Forming

#### General Notes

1. PALSUN sheets can be cold-bent in a straight line (line bending). Standard metalworking tools, like a brake press, may be used for bending. The bending process results in permanent plastic deformation. The degree and quality of this change depend on the thickness of the PALSUN sheet, the final bending angle required, and the actual tools used.
2. When brake forming of PALSUN is conducted, the internal elastic stresses induced along the bent line reduce the mechanical properties, UV resistance, and chemical resistance of the sheet along the bending line. Palram recommends using this process for less demanding applications, and protecting the cold bent areas of the sheet from contact with aggressive chemicals or excessive forces.
3. Annealing can reduce the residual stress level induced by the cold bending process, improving the sheet's mechanical properties.
4. The maximum angles that can be obtained using this process depend on the PALSUN sheet thickness, and the extent of the internal elastic strain. Palram recommends a 24-48 hour delay for sheet to relax after bending. In order to achieve the desired angle, the sheet has to be bent 20-40 degrees in excess of that angle, depending on the angle and sheet thickness. During the stress relaxation period immediately after bending, the bent sheet will expand and regain the required shape.
5. Certain types of sheets are not suitable for either cold or thermal forming, such as PALGARD abrasion resistant sheet. This type is supplied with a tough, scratch-proof finish, which can not be bent and must be installed "as is".

#### Practical Recommendations & Work Instructions

1. Preparations of the PALSUN Sheets and Tooling for Bending:
  - a. Cut the sheet to its required pre-bending size. Palram recommends leaving the protective film on both sides during the cutting, edge preparation and cold bending operations.
  - b. Sand and polish the sheet's edges to a very smooth finish. Rough edges or the tiniest fissure may initiate cracks and fractures at the vicinity of the bending lines, due to internal stresses induced by the bending process.
  - c. Palram recommends conducting preliminary bending tests on small samples of the same (or varied) thickness of the intended sheet, and try a few different values of excess bending. After arriving at a satisfactory result you can start production.
  - d. It is advised to use special tooling, like blades and anvils, designed for plastic sheet bending. Standard metalworking blades and anvils are not necessarily suitable for bending plastic sheets. For plastics, we recommend using a special bending blade with a straight, rounded business edge. The edge radius should be about 4-6 mm (0.16 to 0.24 in.). The thicker the sheet, the larger edge radius required. The anvil channel outer "banks" (corners) should be rounded. Both blade and anvil are to be smooth and polished, with no projections, irregularities or rough edges. Please note that an anvil channel for plastics bending is different than the one suitable for metalworking. It has a wider, flat bottom and much steeper "banks".
2. Cold Bending Fabrication:
  - a. Bending a sheet with an UV protected side (the printed protective film side) on the exterior of the bend gets best results. Therefore, unless otherwise requested, lay the sheet to be bent with the printed side face down.
  - b. For optimal results, perform the brake forming quickly, with an additional 20-40 degrees as explained above, then leave the sheet to relax for 24-48 days.

### 3. Installation

- a. Cold bent polycarbonate is more sensitive to mechanical or chemical abuse in the vicinity of the bend. Therefore, Palram recommends a design that offers better protection for bent areas from any detrimental influence.
- b. Avoid putting additional strain on bent parts, like forcing a bent angle in or out to fit into an existing framework.

## Thermoforming

### Pre-Drying

#### General Guidelines

- Nearly all types of PALSUN sheets are suitable for various thermoforming (TF) procedures. However, due to a native small moisture content absorbed after manufacture, they demand a thorough pre-drying process prior to most thermoforming techniques. During this process, the sheet's temperature will be raised to over 160°C (320°F). Avoiding this preliminary treatment may result in moisture blisters, marring the appearance of the finished product, and/or reduce its properties.
- Higher thicknesses require longer periods in the drying oven.

#### Typical Pre-Drying Time in Oven for Various Thicknesses\*

Sheet Thickness		Drying Time at 125°C (260°F)
mm	Inch	Hours
1	0.04	1.5
2	0.08	4
3	0.12	7
4	0.15	12
5	0.2	18
6	0.24	26
8	0.32	45

Notes: Time for thicker sheets can be calculated through interpolation.

- The sheets are put into an oven, with the protective film removed from both sides, and arranged 20-30mm (3/4"-1") apart, to enable free air circulation. They can be stacked horizontally (on stays or suspended) or vertically- just so they will not be distorted or twisted.
- The pre-drying process should be performed as close as possible to the actual forming. Fully dried sheets taken out of the oven and cooled down to room temperature may be workable within 1 to 10 hours (depending on relative humidity and temperature in the workshop).
- Longer delay may necessitate repeated pre-drying session. A recommended practice, if possible, is leaving the pre-dried sheets in the switched-off oven until the actual thermoforming process. This method saves energy and time on the thermoforming apparatus.



## Guidelines to the Heating Process

- Good quality thermoformed products can only be achieved through a careful and controlled heating process. All parts of the treated sheet should reach even, uniform temperature, achieved by a slow, controlled heating rate, avoiding sudden changes in air circulation and temperature. Such events may result in hot spots and possible distortions. Sheet edges must maintain the same forming temperature as the whole sheet.
- Pre-heating of the clamping frame from 120°C to 130°C is recommended.
- **Temperature Regulation:** Continuous regulation of the sheet's temperature must be maintained inside the thermoforming device itself. PALSUN sheet (of any type) tends to cool quite quickly, and may need a regulating system for adding or dispersing of excess heat on the spot. The sheet's temperature at the thermoforming zone (or the whole sheet) should be kept between 180°C and 210°C during the forming process. Forcing the sheet to form at a lower temperature may induce detrimental internal stresses, reducing the sheet's impact resistance and increasing its chemical sensitivity. Internal stresses are invisible and can be detected only by polarized light. Annealing may reduce the stresses, although it is a complicated process and could be inefficient or impossible to perform in most cases.
- **Protective Polyethylene (PE) masking in Thermoforming:** Special masking is available for sheets intended for thermoforming and should be specified in these cases. This type of masking may be kept on the sheet when practicing most thermoforming methods and peeled off right before performing the procedure. When using sheets with standard masking, it should be removed prior to the thermal treatment, otherwise it is likely to fuse into the sheet's face.

## Hot-Line Bending

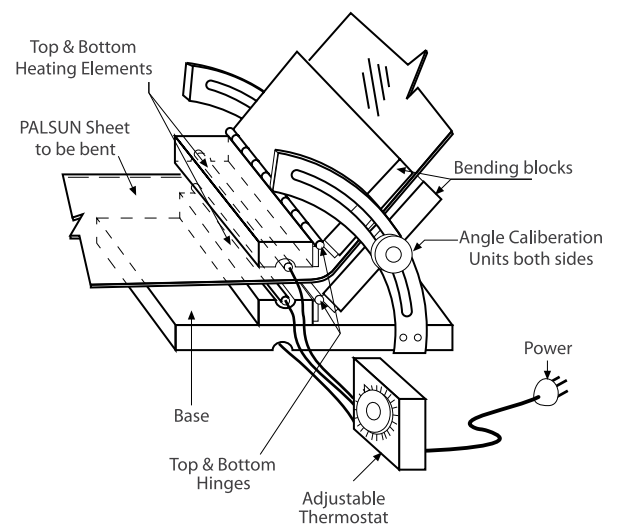
### General Guidelines

1. **Description:** A simple bending technique, used for forming local, straight line, one axis bent parts (such as corners, boxes, and machine guards). This type of bending is usually preferable (if possible) to cold line-bending.
2. **The process:** A bending device with localized heaters on one or two sides of the sheet to be bent is used. The "sandwiched" two-sided heating method is preferable, since it retains the same temperature on both sides at the time. a one-side heater method requires turning the sheet over a few times during the heating period, in order to maintain optimal temperature on both sides.

### Steps & Indications

- One-sided heating method may suffice for sheets up to 3 mm (0.12 in.). Thicker sheets or more demanding cases require using two-sided heating. Keeping control of the sheet's temperature limits of 155-167°C (31-332°F) is of the utmost importance.
- Forcing the bend at lower temperatures will render the sheet fragile at the bend. This simple bending process enables working with regular sheets, without pre-drying. Experimenting with small samples before final execution is highly recommended.

Figure 15: Heat bending device



- **PE Masking:** When preparing for bending of regularly cladded sheets- peel off the masking on both sides of the sheet along the bend line for about 100 mm (4 in) on each side in TF prepared sheets. It is possible to process the sheet with the masking on, up to 5 mm (0.2 in) thickness. For sheets of 6 mm thickness or more the PE masking should be removed along the bending line, as described above. Always test a few samples before proceeding to production.
- **Heaters:** Linear IR (Infrared) or resistance wires strip heating elements are used, preferably with heat reflectors. The width of the heated zone depends on the number of elements used, the spacing between them depends on their specific thermal output and the distance from the target sheet.
- **Bending process:** When the sheet has reached the required temperature the heaters are to be switched off. The sheet, held in pivoted clamps, preferably equipped with a caliper, is then bent to the required angle and secured there until it cools down and sets.
- **Note:** It is recommended to perform the bend a few degrees tighter than the required angle, as the angle may increase as the sheet cools. The desired angle may be reached after a few trials.
- Cooling is to be done in ambient air, taking care to avoid sudden drafts. These can cause distortion of the final product.
- The minimal Hot-Line Bending Radius is 3 times the thickness of the bent sheet. Larger radii can be achieved by widening the heated zone.

### Forming - Notes for Consideration

Local hot line bending (or any other localized heating) induces internal stresses in the finished part, reducing the chemical resistance of the element at the bending line zone. Such treatment is therefore recommended for use in less demanding environments. Localized heating and cooling expansion/contraction characteristics are unpredictable in many cases. Short elements (up to 1.00m or 3.0') usually remain flat. Longer elements may distort to a concave shape (the outer edges are longer than the line-bent side due to uneven contraction).

This phenomenon can be corrected or reduced by simple jigs or frames, which hold the part in the right position during the cooling period.

It is always advised to fabricate experimental test samples to check feasibility of the bending operation.

### PALSUN® Thermoforming Tips

- Consistent part-to-part uniformity is better ensured if the sheet blanks prepared for the thermoforming process are cut from the basic sheet always at the same direction.
- Best results in thermoforming are achieved when parts are heated to temperatures just above the HDT (150 °C- 300 °F).
- Thermoforming parts below the HDT temperature induces internal stresses.
- Secure the cooling area for thermoformed parts against undue drafts. Uneven cooling may result in warping and/or curling of parts.
- Assure precise and systematic control over oven temperature and heating time.
- PALGARD (abrasion resistant) is not recommended for use in thermoforming. The bending and stretching involved during the process will permanently damage the sheets.

### Fault and Remedies in Thermoforming Practice

#	Recognized Fault	Probable Cause	Proposed Treatment	Hot Line Bending	Drape Forming	Vacuum Forming	Free Blown
1	Bubbles in sheet	Moisture content too high	Pre-drying	+	+	+	+
2		Working temp. too high	Decrease working temp.	+		+	+
3	Hair fissures, fragile parts	Part overheated	Decrease heating period			+	+
4		Mold under-heated	Increase mold temp.			+	
5		Late extraction of part	Diminish cooling cycle			+	
6		Vacum speed too high	Reduce vacum rate			+	
7		Mold corners too sharp	Round sharp corners			+	
8		Basic sheet size too small	Increase sheet size			+	
9	Webbing	Erratic heating	Prevent hot or cold spots			+	
10		Mold lead inadequate	Check spacing-min. depth x 2			+	
11		Vacum speed too high	Reduce vacume rate			+	
12		Basic sheet size too large	Clamp/mold spacing <50mm			+	
13	Blurred or partial detailing	Vacum too weak	Seal leaks/add vacum holes			+	
14		Sheet rigid, under-heated	Extend heating period or temp.			+	
15	Product sticks to mold	Mold overheated	Decrease mold temperature			+	
16		Product release delayed	Shorten release period			+	
17		Draft angle too steep	Enlarge draft angle up to 4-6°			+	
18	Marked zones on product	Irregular finish of mold	Treat mold to consistent finush			+	
19		Suction holes misplaced	Install new, better placed holes			+	
20		Sheet overheated	Decrease heating period/ temp.	+	+		
21	Exterior flaws / roughness	Dirt/ grime on sheet / mold	Wipe/Vacum-clean mold/sheet		+	+	
22		Suction holes misplaced	Install new, better placed holes			+	
23	Inconsistent shape of part	Mold/ brace under-heated	Extend pre-heat of mold/brace			+	
24		Irregular heating/ cooling	Prevent drafts, fix faulty heater	+	+	+	+
25		Product release delayed	Shorten release period			+	

# Printing

PALSUN is suitable for all printing methods which are applicable to rigid sheets. It has been tested and approved by leading digital printer manufacturers, achieving excellent results in all parameters. Clear PALSUN sheets match the high clarity of other thermoplastic sheets, yet offer far better adhesion properties and ease of printing with no requirement for any further surface treatment.

## Direct Digital Printing

Wide format (Roll-to-roll) and flatbed printers use various ink and ink curing technologies to allow high quality printing at relatively high speeds. High quality digital printing depends on various factors:

- Printer capabilities
- Ink technology and quality
- Type of printing substrate and quality
- Machine operator

PALSUN is suitable for use with UV curing and solvent-based digital inks, and for IR drying when water-based inks are used. PALSUN will retain its clarity or tint, even after intense UV curing.

## Protective Film Masking

The protective polyethylene film mask helps prevent surface abrasion and stains. However, removing the protective film may cause an increase of static electric charge, which can affect ink coverage. Therefore, after peeling the film away from the sheet, the static electricity that has built up in the sheet should be discharged using an ionized gun or a suitable device provided by the printer manufacturer.

## Cleaning PALSUN® and Preparing for Printing

The surface should be clean before printing. Carefully inspect each panel to ensure there is no: dust, fingerprints, residue or other problematic substances that may affect ink coverage or adhesion. If needed, the PALSUN should be cleaned with a damp rag, or with isopropyl alcohol.

## Ink Adhesion

PALSUN is suitable for all types of inks: aqueous, solvent based, and UV curable. This suitability is affirmed by major printer OEM's, including HP, AGFA, Océ, Gandy Digital, Mutoh, and more. For compatibility information and recommendations, please consult the printer manual or contact the printer manufacturer.

## Ink Drying

There are two main technologies used for ink drying in digital printing:

IR (Infrared) – PALSUN's short and long term service temperatures are 120°C and 100°C respectively, which make it highly suitable for printers with IR drying tunnels.

UV (Ultraviolet) – PALSUN is immune to long term UV exposure and is suitable for UV curing.

## Print Head Adjustment

The distance between the print head and the substrate can have a significant affect on print quality. Manufacturer specifications, combined with operator experience, should determine print head distance from the substrate.

The suggested starting distance should not be more than 2 mm from the print head to the substrate.

## Chemical Resistance

PALSUN sheets are compatible with many materials and chemicals, show limited resistance to others, and are incompatible with a third group, with which contact may be devastating. The mechanism of chemical attack on polycarbonate sheets differs significantly from the mechanism of corrosion of metals. Corrosion of metals results in a gradual loss of surface material as a result of electrolytic action by the relevant chemicals. In the cases where chemical attack on polycarbonate sheet occurs, all or a portion of a range of effects can be observed. Ethylene chloride, chloroform, tetrachloroethane, m-cresol, pyridene and other chemicals can cause partial dissolution of polycarbonate. Swelling agents include benzene, chlorobenzene, tetralin, acetone, ethyl acetate, acetonitrile and carbontetrachloride. Additional effects include color change and/or whitening. These effects may not always lead to product failure, especially for non-loaded sheets. Nevertheless, the level of measured mechanical properties will be reduced. The most critical effect of chemical attack is stress cracking or crazing, which may range in size from being visible to the naked eye to being only observable under a microscope. Stress cracks will always result in sheet failure which will emanate from areas of greatest stress (screws, fixings, bends, etc.).

Polycarbonate sheets are generally not recommended for use with acetone, ketones, ethers, and aromatic and chlorinated hydrocarbons in addition to aqueous or alcoholic alkaline solutions, ammonia gas and its solutions and amines.

Polycarbonate is resistant to mineral acids, many organic acids, oxidizing and reducing agents, neutral and acid salt solutions, many greases, waxes and oils, saturated, aliphatic and cycloaliphatic hydrocarbons and alcohols, with the exception of methanol. The resistance of polycarbonate to water may be described as good up to approximately 60 °C. At higher temperatures, degradation occurs, the extent of which depends on time and temperature. Polycarbonate should therefore not be exposed for long periods of time to hot water. However, brief contact with hot water has no effect. For example, polycarbonate tableware can be washed over 1000 times in a dish washing machine with no adverse effects being observed.

The table that appears on the following pages lists the resistance of polycarbonate sheet to a number of commonly encountered chemicals and other corrosive media at room temperature. (Information on chemical resistance at higher temperatures will be supplied upon request). Where the chemical resistance varies with concentration, the results of tests at different concentrations is presented. The information on chemical resistance is based on our research and experience. (Note that information on compatible adhesives and sealants can be found in a separate leaflet which will be supplied upon request) It serves as a basis for recommendation. PALRAM Industries does not guarantee chemical resistance unless specific separate documentation is supplied.

For chemicals and corrosive media not indicated in the list, please contact your PALRAM representative. He will place you in contact with the PALRAM R&D & Technology Department.

**The table on the following pages uses the following key:**

R - Resistant

LR - Limited Resistance (gradual attack over time may occur)

N - Not Resistant (rapid attack or attack over short time period will occur)

### Chemical Resistance of PALSUN® Sheets at Room Temperature

The chemical resistance of PALSUN & PALTUF sheets, specified in the following pages, has been demonstrated in actual installations and/or laboratory tests. The information in the table is based on our research and experience. It should be considered solely as a basis for recommendation, but not as a guarantee, unless specifically stated in separate documentation supplied by PALRAM Industries.

Chemical	Concentration %*	Resistance	Chemical	Concentration %*	Resistance
Acetaldehyde		N	Butane		R
Acetic Acid	10	R	Butter		R
Acetic Acid	25 (concentrated)	LR (N)	Butyl Acetate		N
Acetone		N	Butyl Alcohol (Butanol)		R
Acetylene		R	Butylene Glycol		R
Acrylonitrile		N	Butyric Acid		N
Ajax Detergent		R	Calcium Chloride	Saturated	R
Allspice		N	Calcium Hypochlorite		R
Allyl Alcohol		LR	Calcium Nitrate		R
Alum (Aluminum Ammonium Sulfate)		R	Calcium Soap Fat		R
Aluminum Chloride	Saturated	R	Camphor Oil		N
Aluminum Oxalate		R	Carbolic Acid		N
Aluminum Sulfate	Saturated	R	Carbon Bisulfite		N
Ammonia (Gas)		N	Carbon Dioxide Gas (Moist)		R
Ammonia (Aqueous)		N	Carbon Disulfide		N
Ammonium Carbonate		LR	Carbon Monoxide		R
Ammonium Chloride		R	Carbon Tetrachloride		N
Ammonium Fluoride		N	Castor Oil		R
Ammonium Hydroxide		N	Catsup (Ketchup)		R
Ammonium Nitrate		R	Caustic Potash (Potassium Hydroxide)		N
Ammonium Sulfate	Saturated	R	Caustic Soda (Sodium Hydroxide)		N
Ammonium Sulfide		N	Chlorine Gas (Dry)		LR
Amyl Acetate		N	Chlorine Gas (Wet)		N
Amyl Alcohol		LR	Chlorobenzene		N
Aniline		N	Chloroform		N
Antimony Trichloride	Saturated	R	Chocolate		R
Aqua Regia (3 parts HCl:1 part HNO <sub>3</sub> )		LR	Chrome Alum	Saturated	R
Arsenic Acid	20	R	Chromic Acid	20	R
Automatic Switch Grease		R	Cinnamon		R
Automotive Waxes		LR	Citric Acid	10	R
Baby Lotion		R	Cloves		N
Bacon Fat		R	Coal Gas		R
Barium Chloride		R	Coca Cola		LR
Battery Acid		R	Cocoa		LR
Beer		R	Cod Liver Oil		R
Beet Syrup		R	Coffee		LR
Benzaldehyde		N	Cooking Oil		R
Benzene		N	Copper Sulfate	Saturated	R
Benzoic Acid		N	Cresol		N
Benzyl Alcohol		N	Cupric Chloride	Saturated	R
Betadine		R	Cuprous Chloride	Saturated	R
Bleach (Clorox)		R	Cyclohexane		R
Blood and Blood Plasma		R	Cyclohexanol		LR
Borax		R	Cyclohexanone		N
Boric Acid		R	DDT		R
Brake Fluid		N	Dekalin		R
Bromine		N	Detergent (most)		LR or R
Bromobenzene		N	Developing Solutions		N or LR

Entries indicate the following: R - resistant, LR - limited resistance, N - not resistant

\*Concentration of aqueous solution except where noted

Chemical	Concentration %*	Resistance	Chemical	Concentration %*	Resistance
Diamyl Phthalate		N	Kerosene		R
Diesel Fuel		R	Lactic Acid	20	R
Diethyl Ether (Ethyl Ether)		N	Lacquers and Thinners		R
Dimethyl Formaldehyde (DMF)		N	Laundry Detergents (Most)		R
Dimethyl Sulfoxide (DMSO)		N	Ligroin (Hydrocarbon Mixture)		R
Dinonyl Phthalate (plasticizer)		LR	Lime Solution (2%) or paste		R
Doctyl Phthalate (plasticizer)		LR	Liquors or Liqueurs		R
Dioxane		N	Linseed Oil		R
Diphyl 5,3		LR	Loctite		R
Ethanol (Ethyl Alcohol) and Water	96	R	Lubricating Oils (Most)		R
Ethanol (Ethyl Alcohol)	Pure	LR	Machine Oils (Most)		R
Ethyl Amine		N	Magnesium Chloride	Saturated	R
Ethyl Acetate		N	Magnesium Sulfate	Saturated	R
Ethyl Bromide		N	Manganese Sulfate	Saturated	R
Ethylene Chloride		N	Margarine		R
Ethylene Chlorohydrin		N	Mayonnaise		R
Ethylene Dichloride		N	Meat		R
Ethylene Glycol (Antifreeze)		LR	Mercuric Chloride	Saturated	N
Ferric Chloride	Saturated	R	Mercury		N
Ferrous Sulfate		R	Methane		R
Fish and Fish Oils		R	Methanol (Methyl Alcohol)	Pure	LR
Floor Polish		R	Methylamine		R
Formalin	10%	R	Methylcellusolve		N
Formic Acid	10% (30%)	R (LR)	Methylene Chloride		N
Freon TF		R	Methyl Ethyl Keton (MEK)		N
Freon (all others)		N	Methylmethacrylate		N
Fruit Juices and Pulp		R	Milk		N
Gasoline		N	Mineral Oil		R
Gear Oil		R	Motor Oils (Most)		R
Glazers Putty		R	Mustard		R
Glucose		R	Naphtha (Stanisol)		R
Glycerine		R	Nickel Sulfate		N
Glycerol		R	Nitric Acid	20	R
Glycols		R	Nitrobenzene		R
Glutaraldehyde	50%	R	Nitropropane		R
Grease, Automotive (Most)		R	Nitrous Oxide		R
Heptane		R	Nutmeg		N
Hexane		R	Oleic Acid		N
Hydrazine		N	Onions		R
Hydrochloric Acid	20 (Concentrated)	R (N)	Oxalic Acid	10	R
Hydrofluoric Acid	20	R	Oxygen		R
Hydrogen Peroxide	30	R	Ozone		R
Hydrogen Sulfide		R	Paprika		R
Iodine (aqueous solution)	5	R	Paraffin		R
Iodine		N	Pentane		LR
Inks (Most)		R	Pepper		LR
Isoamyl Alcohol		LR	Perchloric Acid	10 (concentrated)	N
Isopropyl Alcohol		R	Perchloroethylene		R

Entries indicate the following: R - resistant, LR - limited resistance, N - not resistant

\*Concentration of aqueous solution except where noted

Chemical	Concentration %*	Resistance	Chemical	Concentration %*	Resistance
Petroleum		LR	Sodium Sulfide		N
Petroleum Ether		LR	Sodium Thiosulfate		R
Petroleum Oil (Refined)		R	Spindle Oil		R
Phenol		N	Stannous Chloride		R
Phosphoric Acid	10	R	Starch		R
Phosphorous Oxychloride		R	Styrene		N
Phosphorous Pentoxide	25	LR	Sugar	Saturated	R
Phosphorous Trichloride		N	Sulfur Dioxide (Gas)		R
Polyethylene		R	Sulfuric Acid	<50 (50<70)	R (LR)
Polyethylene Glycol		R	Sulfurous Acid	10	N
Potassium Acetate		LR	Sulfuryl Chloride		N
Potassium Aluminum Alum (Sulfate)	Saturated	R	Tapping Oil		R
Potassium Bichromate		R	Tartaric Acid	30	R
Potassium Bromate		R	Tear Gas (Chloracetophenone)		LR
Potassium Bromide		R	Terpineol		N
Potassium Chloride	Saturated	R	Tetrahydrofuran		N
Potassium Cyanide		N	Tetralin		N
Potassium Dichromate	Saturated	R	Thiophene		N
Potassium Hydroxide		N	Thyme		R
Potassium Metabisulfite	4	R	Titanium Tetrachloride		R
Potassium Nitrate	Saturated	R	Tobacco		R
Potassium Perchlorate	10	R	Toluene		N
Potassium Permanganate	10	R	Transformer Oils		R
Potassium Persulfate	10	R	Transmission Fluid		R
Potassium Rhodanide	Saturated	R	Trichloroacetic Acid	20	LR
Potassium Sulfate	Saturated	R	Trichloroethylamine		N
Propane		R	Trichloroethylene		N
Propargyl Alcohol		R	Trichloroethylphosphate		LR
Propionic Acid	20	R	Tricresylphosphite		N
Propionic Acid	Concentrated	N	Trisodium Phosphate		R
Propyl Alcohol (1-Propanol)		R	Turpentine		LR
Pyridine		N	Urea		R
Salad Oil		R	Vacuum Pump Oil		R
Salt		R	Vanilla		R
Silicofluoric Acid	30	R	Vanillin		R
Silicone Grease		R	Varnish		N
Silicone Oil		R	Vaseline		R
Silver Nitrate		R	Vegetable Juices		R
Soap (Ivory)		R	Vegetable Oils		R
Sodium Bicarbonate	Saturated	R	Vinegar		R
Sodium Bisulfate	Saturated	R	Water (Demineralized or Sea)		R
Sodium Bisulfite	Saturated	R	White Spirit		N
Sodium Carbonate	Saturated	R	Wine, Whiskey, Vodka, Rum, Cognac		R
Sodium Chlorate		R	Witch Hazel		R
Sodium Chloride	Saturated	R	Worcester Sauce		R
Sodium Chromate		R	Xylene		N
Sodium Hydroxide		N	Zinc Chloride		R
Sodium Hypochlorite	5% Chlorine	R	Zinc Oxide		R
Sodium Nitrate		N	Zinc Stearate		R
Sodium Sulfate	Saturated	R	Zinc Sulfate		R

Entries indicate the following: R - resistant, LR - limited resistance, N- not resistant. \* Concentration of aqueous solution except where noted. The chemical resistance information in this table is based on our research and experience and may be considered solely as a basis for recommendation, but not as a guarantee, unless specifically furnished as such by Palram.



## Adhesives and Sealants

Adhesives and sealants are a special class of substances often required during installation or fabrication of PALSUN. The guidelines for their use, appearing below, must be followed.

1. Use only sealants, adhesives, rubber packing, sealing strips & gaskets that are compatible with PALSUN and approved by Palram or its distributors. An updated list of compatible adhesives and sealants can be found in the [Recommended Adhesives and Sealants for Palram Polycarbonate Products brochure](#) (Also available from [www.palram.com](http://www.palram.com)). EPDM rubber sealing strips and gaskets are the preferred choice, (though the use of neoprene is permitted) due to a longer life expectancy and durability.
2. Use of sealants, adhesives and other sealing products not included in the recommended list "Recommended Adhesives & Sealants for Palram Polycarbonate Products" must receive the Manufacturer's explicit approval, which can be obtained through your local distributor.  
**Important:** Soft PVC gaskets and/or sealing strips are absolutely forbidden for use, as they are detrimental and may cause sheet failure.
3. Use of materials that are not on the list, and/or which have not received the Manufacturer's explicit approval, may harm the sheets and void all warranties and any responsibility of the Manufacturer for the performance of PALSUN.
4. Your local distributor can provide additional information, and forward materials for testing and evaluation of their compatibility with the PALSUN sheets.
5. See [Milling & Joining section on page 27](#) for additional specific details.

## Selection of the Appropriate PALSUN® Sheet

PALSUN sheets are manufactured in thicknesses of 1.0 to 12 mm.

### PALTUF® Sheets

Intended mainly for indoor use (transparent partitions, interior design applications, industrial shields, and thermoformed items). They are also used in pavilions (exhibitions), or other temporary structures. Use of PALTUF sheets outdoors, for permanent applications, even in areas with mild UV radiation (Northern Europe, USA, Canada and similar) is not recommended.

### Thin PALSUN® Sheets

Frequently used in temporary structures, (exhibitions, pavilions etc.). These products may also be used in conservatories or other horticultural / agricultural structures, where economy and lower cost are imperative. They are repeatedly used in Thermoforming applications, the forms generated render them rigid and suitable for special requirements, in signs and other advertising elements.

### PALSUN® Sheets for Permanent Glazing Applications

The recommended permanent installation method is inside a suitable supporting frame, made of metal (steel or aluminum), wood or rigid PVC profiles. Glazing thickness is determined according to the sash width of said frame, the wind/snow loads dictated by the environmental conditions and the building codes in place at the project location.

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