

PALSUN®

Flat Solid Polycarbonate Sheets

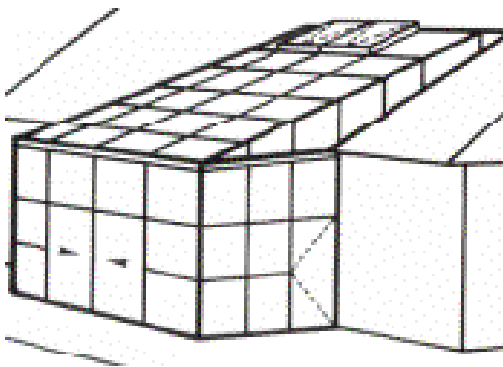


PALGARD™

Flat Solid Polycarbonate Abrasion Resistant Sheets

Architectural, Safety & Security **Glazing Guide**

for Designers, Engineers & Professional Consultants





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PART A. DATA & PRINCIPAL INDICATIONS FOR USE

1. Introduction, abbreviated Definitions & Typical Glazing Applications:

PALSUN®: Flat solid polycarbonate sheet, in transparent & translucent configuration, for use as safety & security glazing, in flat or curved configurations. PALSUN family Includes many types as could be observed further on.

PALGARD™: Flat solid polycarbonate sheet, mostly in transparent configuration, with additional abrasion resistant silica coat on one or two sides, for enhanced resistance to scratches, vandalism and graffiti, chemical attack & haze. A member of the PALSUN family. Contrary to regular PALSUN, PALGARD sheets should always be installed in the flat position, never to be curved, as it might crack the silica coat(s).

Polycarbonate: A thermoplastic material offering extraordinary strength & impact resistance along with very high flexibility, glass-like transparency & light-transmission, relatively high working temperature range & excellent workability & fabrication qualities. Can be fabricated & formed in practically any available industrial process, such as extrusion, thermoforming, injection-molding, casting etc. Polycarbonate glazing/cladding (of any type) blocks completely the whole range of harmful solar UV radiation, while transmitting the whole range of visible light and near IR radiation. Therefore, People and hardware covered by polycarbonate elements have the best protection against deterioration & disintegration from UV radiation

This guide refers to flat solid polycarbonate sheets produced by an industrial co-extrusion process.

Possible Applications:

- Windows in buildings of all types,
- Glazed curtain walls and light-transmitting roof-cover.
- Natural lighting apertures (Skylights, Sidelights) in roofs and walls.
- Transparent indoors partitions.
- Transparent acoustical barriers on side of roads & highways and noisy public places (schoolyards, playing grounds, stadiums & sport arenas, automotive sports etc.)
- Transparent stationary and mobile shields of all types.
- Windows for transportation vehicles (trains, buses & cars, aircraft, ships & boats etc.).

PALSUN & PALGARD may come in a variety of thickness, shades & colors & light-transmission rates. PALSUN may also come in a number of surface finishes.

Important Note:

PALGARD is a part of PALSUN family and identical in most details and properties. Whenever and wherever PALSUN is mentioned in this manual PALGARD is included, and vice versa, unless specifically stated otherwise.

2. PALSUN Family:

Table 1. PALSUN Family – Description & Indications for Use

Ser. No.	Type & Name of Product	Description	Comments & Indications for Use
A	B	C	d
1	PALTOUGH	UV stabilized sheet, smooth on both sides	For indoor applications only. Available also in other configurations as appears in paragraph 4, 5 & 6 in the table.
2	PALSUN	Sheet smooth on both sides, with integral co-extruded UV protective layer on its external side.	Applied on exterior wall windows, curtain-walls, skylights & sidelights or internal artificial lighting elements
3	PALSUN plus	Sheet smooth on both sides, with integral co-extruded UV protective layers on both sides.	To be applied in open outdoors glazing, with possible UV exposure on both sides (sound barrier for instance) & external artificial lighting elements
4	PALSUN Embossed	Sheet embossed on one side, with integral co-extruded UV protective layer on the external smooth side, unless otherwise required	Possible UV protective layers on both sides. 3 possible embossing shapes: "hill & valley", "Prismatic", "Hair-Cell"
5	PALSUN Matte Finish	Sheet smooth on one side, with anti-glare matte finish for better light diffusion, on the other	With integral co-extruded UV protective layer on the external side or on both.
6	PALSUN FR	An high fire resistance sheet, conforming to US Fire Standard UL 94 V-0	With integral co-extruded UV protective layer on the external side or on both. Available in all possible combinations appearing in this table.
7	PALSUN Solar-Control	A tinted, metallic hued, semi-reflective sheet with integral solar-radiation control enabling regulated transmission of visible light with reflectance of most solar longer wave heat radiation	With integral co-extruded UV protective layer on the external side or on both. Available in aluminum shade (gray) & Solar Ice (pearly -white). Other hues & colors on special demand subject to minimal quantity order.
8	PALSUN Mirror	Sheet smooth on both sides, with integral co-extruded UV protective layer on its external side & mirror metallic coated film on the other .	For indoor & outdoor applications. Internal mirror finish film will always be installed against a rigid, sealed backup or other sealed, impermeable protective element.
9	PALGARD Clear	A colorless transparent sheet, smooth on both sides, with integral co-extruded UV protective layer on the external side (or both) & abrasion resistant silica coat on one side (generally external) or both.	Other tints (bronze, gray etc.) at 5% surcharge & 5.0 t min. order. To be used same as flat PALSUN glazing (and variants) with enhanced cleaning options & improved scratch resistance To be installed in the flat position only.
10	PALGARD Translucent	Same as PALGARD Clear but in special-order translucent version.	Non-standard. Available At special order, min. 5 t. per order /color + agreed surcharge

Notes:

1. all PALSUN & PALGARD sheets appearing in the table are produced with polyethylene protective masking on both sides of the sheet (or on one side on special order). The UV protected side (and the silica coated side on PALGARD) is clearly marked on the appropriate protective film. The masking would be peeled-off only during actual installation or immediately after its conclusion.
2. For instructions on transportation, handling & storage see relevant sections further on in this manual.
3. PALSUN & PALGARD sheets carry 10 years limited guaranty, as appears in PALRAM Guaranty Certificate, provided on demand.
4. PALSUN & PALGARD sheets can be supplied as transparent, translucent or opaque configurations, in a few standard sizes, colors & tints, thickness & light-transmission. Non-standards properties upon special demand, subject to minimal order & agreed surcharge. For more details contact local PALRAM dealer.

3. Standard Dimensions, Weight & Colors:

Table 2. PALSUN Standard Dimensions, Weight, Colors & Tints:

Thickness	Standard Dimensions (mm x mm)			Theoretical Weight	Standard Colors & Hues		
	mm	1250 x 2050	1220 x 2440		2050 x 3050	gr/m ²	Transparent
1.0				NA	1,200	Colorless Bronze Solar-Gray Solar-Control Solar-Ice	Matte (Diffuser) Opal-White
1.5				NA	1,800		
2.0					2,400		
3.0					3,600		
4.0					4,800		
5.0					6,000		
6.0					7,200		
8.0					9,600		
10.0					12,000		
12.0					14,400		

Table 3. Standard PALGARD Sheets/Panels:

Thickness	Standard Dimensions	Theoretical Weight	Standard Colors & Tints		
			mm	mm x mm	gr/m ²
3.0	2000x3000	3,600		colorless Other standard colors (bronze or similar)- 5% surcharge, min.5 t. per order /color	Non-standard. At special order, min. 5 t. per order /color + agreed surcharge
4.0		4,800			
5.0		6,000			
6.0		7,200			
8.0		9,600			
10.0		12,000			
12.0		14,400			

Notes:

1. *PALSUN Non-Standard Choices: Other colors & shades, in-between thickness, width & length other than production standard are available to special order, subject to minimal agreed quantity.*
2. *Certain PALSUN types are produced in limited choice of thickness, size, finish or color/tint. Please consult your local PALRAM distributor about availability prior to order.*
3. *When a certain color or tint is required it is advisable to ask the distributor or salesperson for a typical agreed color sample which would be the only binding proof for the true color ordered.*
4. *Final shade of a sheet's color would be determined by the thickness & light-transmission percentage requested. A thicker sheet would need lighter shade for a fixed percentage.*
5. *Standard PALGARD sheets are produced only in 2.00 x 3.00m dimensions, in 3-12mm thickness & colorless hue.*

4. Polycarbonate General Characteristics & Physical Properties:

Table 4: Typical Properties of PALSUN, PALTOUGH & PALGARD Sheet (3 mm = 0.12 in.)

Property	Conditions (U.S. Customary) ^a	ASTM Method ^b	Units - SI (U.S. Customary) ^a	Value (U.S. Customary) ^a
Physical				
Density		D-1505	g/cm ³ (lb/ft ³)	1.2 (75)
Water Absorption	24 hr. @ 23°C	D-570	%	0.15
Mechanical				
Tensile strength at yield	10 mm/min (0.4 in./min)	D-638	MPa (psi)	65 (9,400)
Tensile strength at break	10 mm/min (0.4 in./min)	D-638	MPa (psi)	60 (8,800)
Elongation at yield	10 mm/min (0.4 in./min)	D-638	%	6
Elongation at break	10 mm/min (0.4 in./min)	D-638	%	>90
Tensile Modulus of Elasticity	10 mm/min (0.4 in./min)	D-638	MPa (psi)	2,000 (290,000)
Flexural Modulus	1.3 mm/min (0.052 in./min)	D-790	MPa (psi)	2,600 (380,000)
Flexural Strength at Yield	1.3 mm/min (0.052 in./min)	D-790	MPa (psi)	100 (14,500)
Notch Impact Strength Izod	23°C (73°F)	D-256	J/m (ft-lbf/in.)	800 (15)
Notch Impact Strength Charpy	23°C (73°F)	D-256	J/m (ft-lbf/in.)	800 (15)
Impact Falling Weight		ISO-6603/1 ^b	J (ft-lbf)	158 (117)
Rockwell Hardness		D-785	R scale / M scale	125 / 75
Thermal				
Long Term Service Temperature			°C (°F)	-75 to +100 (-175 to +212)
Short Term Service Temperature			°C (°F)	-75 to +120 (-175 to +250)
Heat Deflection Temperature	Load: 1.82 MPa (264 psi)	D-648	°C (°F)	130 (265)
Vicat Softening Temperature	Load: 1 kg (2.2 lb)	D-1525	°C (°F)	150 (300)
Coefficient of Linear Thermal Expansion		D-696	10 ⁻⁵ /°C (10 ⁻⁵ /°F)	6.5 (3.6)
Thermal Conductivity		C-177	W/m ² K (Btu-in./hr-ft ² -°F)	0.21 (1.46)
Specific Heat Capacity		C-351	kJ/kg·K (Btu/lb·°F)	1.26 (0.31)
Optical				
Haze		D-1003	%	<0.5
Light Transmission		D-1003	%	89
Refractive Index		D-542		1.59
Yellowness Index		D-1925		<1

Notes:

1. Conditions, units and values in the table, in U.S. Customary units, are presented within brackets.
2. Results depicted in this table were obtained by following indicated ASTM method, except where another method is indicated by a (b) symbol.
3. All 3 sheet types are basically polycarbonate, with identical properties, save additional thin UV protective layer(s) or the ultra-thin silica (abrasion resistant) coat(s) and their contribution to the specific sheet behavior.
4. Test results depicted correlate (when applicable) to a 3.0mm (1/8 in.) thick sheet.



5. PALGARD Enhanced Attributes (Compared with regular PALSUN):

- a. **Visible Light Transmission:** Improved by PALGARD silica coat by approximately 1.5% (to 91%)
- b. **Yellowing Index:** Improved by PALGARD silica coat to < 0.75.
- c. **Chemical Resistance:** PALGARD coated side presents better resistance than the non-coated side, or parallel PALSUN or PALTOUGH. It could be subjected, for limited periods, to harsher chemicals or more effective cleaning agents during removal of persistent grime or occasional graffiti.
- d. **Cleaning Persistent Grime & Graffiti Removal:** PALGARD coated side can withstand spray-paints, motor oils, alcohol based markers & other relatively aggressive chemicals along with brisk use of alcohol, kerosene and even gasoline as cleaning agents.

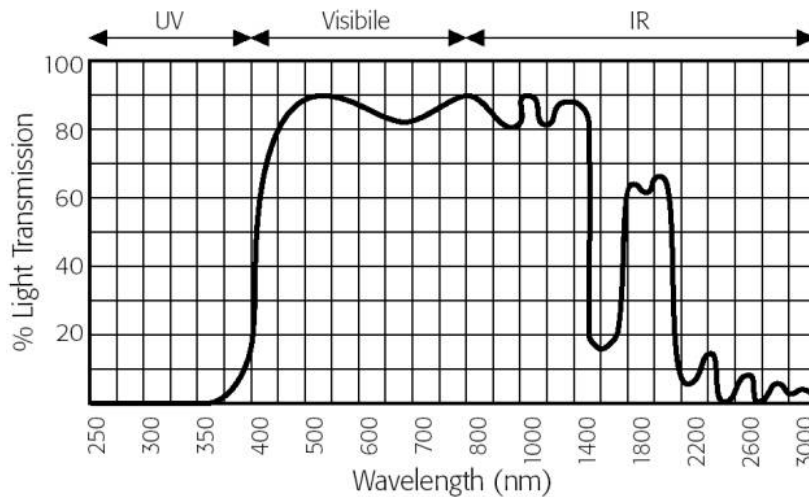
PALSUN or PALTOUGH are more vulnerable to these materials and might be harmed by contact with them.. Damage scope depends on duration of exposure & type of chemical.

Resistance duration to each cleaning agent differs, so use it gradually, from the most gentle to the harshest. Wash-off immediately as cleaning is completed, with lots of clean water and mild detergent.

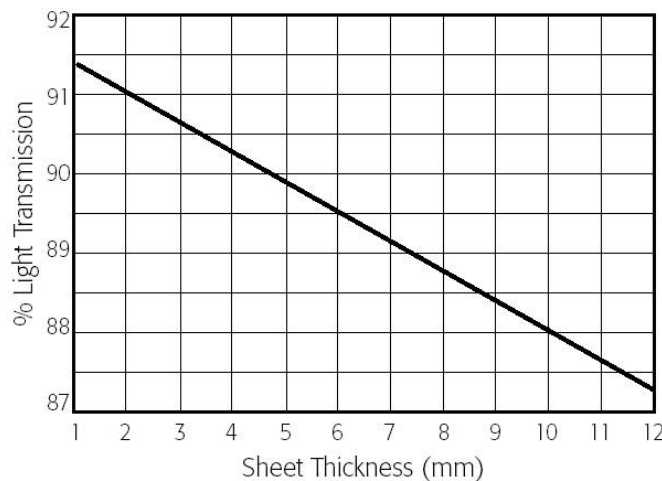
- e. **Weather Resistance:** PALGARD coated side(s) offers even better weathering durability, confirmed by thousands of hours of accelerated exposure and years of field tests in harsh climate conditions.
- f. **Abrasion Resistance:** PALGARD meets ASTM D-1044 & ANSI Z26.1 TEST #17 Taber Abrasion Test with good results, displaying good resistance to friction & chaffing with people in crowds. PALGARD can endure intentional abuse to a measure, however once gouged by sharp objects (knives, screwdrivers etc), a deeply scratched surface could not be restored.

6. PALSUN® & PALGARD™ Optical Characterization & Properties:

- a. **Blocking UV Radiation:** All the siblings of the solid polycarbonate sheets family block practically all the destructive & harmful UV radiation range (250 to 400 nm), and a considerable part of the long-wave far IR (Infra-Red) heat radiation range (see graph 1).
- b. **Visible-Light Transmission:** In this 400 to 800 nm wavelengths range a typical clear, colorless PALSUN (or the two others) will transmit about 87 to 91 percent of the incident visible light radiation.
- c. **Light-Transmission as a Function of Sheet Thickness:** Percentage of light transmission drops slightly & linearly with each gradual increase in thickness (see graph 2).



Graph 1. % Light Transmission of PALSUN & PALGARD Sheet (3 mm) Versus Wavelength



Graph 2. PALSUN & PALGARD Sheet % Light Transmission Versus Sheet Thickness

Table 4. PALSUN & PALGARD Optical & Thermal Properties - Solar Radiation Transmission

PALSUN Type (Standard PALGARD Comes only in Clear)	Thickness (mm)	LT %	LR %	ST %	SR %	SA %	SR _t %	ST _t %	SC	
		Obligatory Standard / Testing Method								
		ASTM D- 1003	ASTM E424-71							
Clear	3.0	88	10	84	10	4	12	88	1.00	
Clear Embossed	3.0	85-87	10-12	81-83	10-12	3-7	14	86	1.00	
Bronze	50%	All	50	7	54	7	39	26	74	0.75
	35%		35	6	42	6	52	32	68	0.64
	20%		20	6	28	6	66	39	61	0.52
Solar Gray	50%	All	50	7	54	7	39	37	63	0.75
	35%		35	6	42	6	52	32	68	0.64
	20%		20	6	27	6	67	38	62	0.54
Opal-White	1.0	35	55	40	47	13	53	47	0.54	
	1.5	45	50	48	41	11	46	54	0.52	
	2.0	39	54	42	45	13	52	48	0.41	
	3.0	28	58	36	48	14	57	43	0.35	
	4.0	19	59	24	61	15	69	31	0.31	
	5.0	14	60	21	72	17	71	29	0.26	
Solar Control (Aluminum Gray)	20%	All	20	30	18	33	49	58	42	0.36
	35%		35	28	35	28	37	47	53	0.54
	50%		50	24	48	24	28	48	52	0.64
Solar Ice (Pearly White)	35%	All	35	56	33	49	18	58	42	0.34
	50%		50	45	46	38	16	46	54	0.51

Notes:

1. Values in this table are based mostly on known data about the various sheets in it and partly on theoretical calculations & interpolations. Performance of other sheets absent from table would be assessed by approximated extrapolations.
2. See enhanced definitions below for acronyms on top of table.

Definitions

- Visible Light Radiation:** The range of the light spectrum wavelength from 400 to 700 nm.
- % Light Transmission (%LT):** Percentage of incident visible light passing through a light transmitting object.
- % Light Reflection (%LR):** Percentage of incident visible light striking an object, reflecting back as is.
- % Light Absorption (%LA):** Percentage of incident visible light striking an object and absorbed by it.
- %LT + %LR + %LA = 100%**
- Solar Radiation:** The solar spectrum ranging from 300 to 2400 nm. Includes UV, visible, NIR & FIR radiation.
- % Solar Transmission (%ST):** Percentage of complete range of incident solar radiation passing directly through a light transmitting object.
- % Solar Reflection (%SR)**
% Solar Absorption (%SA): Percentage of incident solar radiation striking an object, reflecting back as is. Percentage of incident solar radiation that strikes an object and is absorbed by it.
- %ST + %SR + %SA = 100%**
- Total Solar Transmission (%ST_t):** Percentage of incident solar radiation transmitted by an object, including the direct solar transmission plus a part of the solar absorption reradiated inward.
- Total Solar Reflection (%SR_t):** Percentage of incident solar radiation reflected by an object, including solar reflectance plus a part of the solar absorption, reradiated outward.
- %ST_t + %SR_t = 100%**
- Shading Coefficient (SC):** The ratio of total solar radiation transmitted by a given material to that transmitted by a regular clear glass, with 87% LT.
It can be approximately calculated by: $SC = 1.15 \times (\%ST + 0.27 \times \%SA) / 100$
 $\%ST + 0.27 \times \%SA = \%ST_t$
 $SC = 1.15 \times ST_t / 100$



7. PALSUN® Thermal-Insulation Properties:

PALSUN is not an insulating material, but still offers lower thermal conductivity and better insulation than comparable glass. When considering thermal efficiency and energy lose in winter (heating) or summer (air-conditioning) PALSUN may contribute substantially in lowering total heating & cooling cost & energy cutback for single glazing systems.

Table 5. PALSUN Vs. Glass Heat Insulation Comparison:

Glazing thickness		PALSUN	Glass
mm	in.	K Value	
3.0	1/8	5.49	5.87
5.0	13/64	5.21	5.80
6.0	1/4	5.09	5.77
9.5	3/8	4.69	5.68
12.0	1/2	4.35	5.58

Notes:

1. Where PALSUN is mentioned it holds for PALGARD too. Its properties are identical to PALSUN.
2. PALSUN K-value shows significant drop (better insulation) as thickness grows. Compared to glass 12mm PALSUN glazing offers better insulation by more than 20% than its glass counterpart.
3. In between values to be calculated by interpolation.

8. PALSUN® Acoustic Properties:

Though less than half the weight of an equivalent glass pane, PALSUN glazing offers quite close sound insulation properties along with much higher impact strength.

These combined properties make PALSUN glazing an excellent candidate for see-through sound barriers: lightweight, easy to maintain or replace if necessary, highly transparent and vandal-proof.

PALGARD, with identical inherent basic properties and more, portrays even better advantages for choosing it for the job(see page 7).

Following table portrays the acoustic performance of PALSUN glazing compared to glass:

Table 6. PALSUN Vs. Glass Sound Insulation Comparison:

Glazing Thickness		PALSUN Glazing Sound Reduction	Glass Pane Sound Reduction
mm	in.	dB	dB
4	5/32	24	30
5	13/64	25	30
6	1/4	26	31
8	5/16	28	32
10	25/64	30	33
12	1/2	31	34

Notes:

1. Sound insulation/noise reduction values refer to single layered solid glazing pane of the depicted thickness for both materials.
2. The somewhat higher acoustic reduction value of comparable glass results from its higher specific weight/density (more than twice than that of polycarbonate).

9. Durability under Environmental & Climatic Conditions:

The UV segment of the Solar radiation is destructive and harmful to most plastics & polymers. The extent of crazing, deterioration of external surface & final disintegration depends on type of polymer and duration of exposure.

Further damage and accelerated deterioration might be caused by environmental aspects such as ice, water & humidity, extreme temperature changes, strong winds with dust and sand particles, air & chemical pollution etc. Amount of damage depend on location, height (above sea level and relative to near surroundings) climate conditions, air pollution level & nature etc.

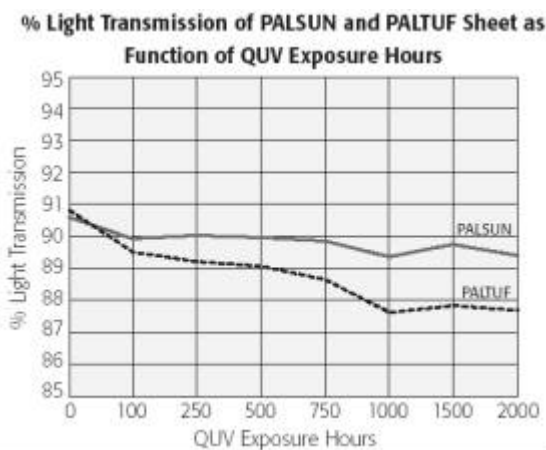
A typical & easily recognizable sign of deterioration is substantial yellowing followed by significant transparency loss, surface roughness & shallow crazing. Such deterioration also indicated a serious drop in strength and impact resistance.

PALSUN and PALGARD of all types are UV shielded by an integral co-extruded UV protective layer, on one (external) or both sides (for outdoors applications), providing long-term safeguard against UV deterioration. Both sheets are inherently resistant to extreme weather conditions most environmental circumstances. PALGARD has a few more enhanced attributes as mentioned in page 7.

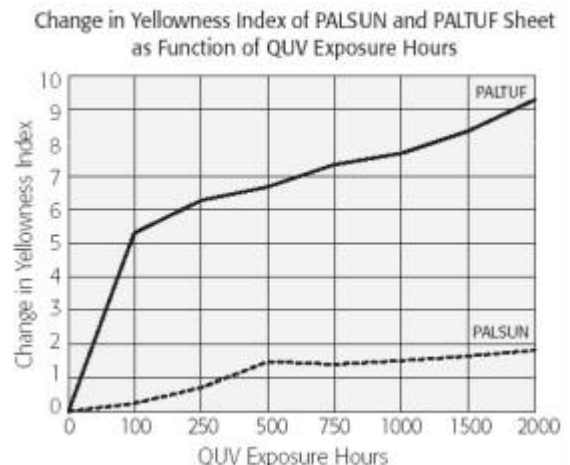
QUV Laboratory tests (accelerated UV exposure) made according to ASTM E-58 (88) US Standards show that after 2,000 h of accelerated exposure, equal to 20 years of normal exposure to intensive solar radiation at hot & sunny climates, there was an almost negligible reduction in light transmission and minimal decrease in physical properties.

All the above assure product longevity and years of service. PALSUN and PALGARD will keep their look, strength & optical quality for many years of service, under extreme conditions and intensive exposure to direct sunlight with the minimal reduction of physical properties.

Following graphs show influence of said QUV tests on unprotected polycarbonate sheet Vs PALSUN.



Graph 3. Change in % Light Transmission as a Result of QUV Exposure Hours (PALTUF-flat solid polycarbonate sheet for indoors use)



Graph 4. Change in Yellowness Index as a Result of QUV Exposure Hours



10. Flammability:

General Comment: As a thermoplastic, regular PALSUN eventually melts and burns under the intense heat of a blazing fire. However, PALSUN does not propagate flame. It solidifies and self-extinguishes as soon as the direct flame is taken away.

Regular PALGARD behavior is the same, though when silica coated on both sides the coats help to retard the glazing from catching fire for a few more minutes, as silica is inert to fire.

PALSUN® FR: Flame retardant additives make the sheets virtually non-combustible. When the flame licks the glazing it only gets scorched and eventually melts, solidifying quickly when the direct heat source is removed.

Drippings do not ignite other combustible materials, as they actually do not 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 eventually produce apertures in the glazing, enabling heat and smoke to escape, thus reducing temperatures inside the structure and extracting the asphyxiating smoke. It helps cooling the interior and facilitates firemen duty in extinguishing the fire.

Flammability Classifications: PALSUN & PALSUN FR, same as parallel PALGARD, are classified as appears in the following table, based on tests executed by certified independent testing laboratories.

Table 8: PALSUN® Fire Classifications listed according to the relevant codes or standards

PALSUN® Type	Standard	Country	Description	Classification
Regular PALSUN PALGARD	DIN 4102	Germany	-	B-1
	BS 476/7	UK	Clear	Class 1Y
	NSP 92501, 4	France	Clear	M-1, M-2 (depend on thkns)
	CSE RF 2/75/A CSE RF 3/77	Italy	-	Class 1
	UL-94	USA	-	V-0, V-1, V-2*
PALSUN FR PALGARD FR	NSP 92501, 4	France	Clear	M-1
	UL-94	USA	Clear/Opaque	V-0
	ASTM D-2863-87		Clear/Opaque	LO.I. = 30
	AU 1530.3-1982	Australia	All	Ignitability Index = 9
				Spread of Flame Index = 8
	Heat Evolved Index = 10			
	Smoke Developed Index = 8			

Note: *Classification depends on



11. PALSUN® Chemical Resistance:

- a. PALSUN glazing of all types are compatible with many common materials and chemicals, show limited resistance to others, and are utterly incompatible with a third group, with which contact may be harmful and even devastating.

Damage extent depends on type of material or chemical the glazing may be exposed to, and on the nature and duration of said exposure.

- b. PALGARD uncoated side reacts to the three chemical groups same as regular PALSUN, while the silica coated face portrays higher resistance to materials & chemicals enabling better cleaning and graffiti removal options. (See page 7)
- c. A wider & more detailed table depicting PALSUN resistance to a wide range of chemicals appear in Appendix 1, page XX.

12. Sealants, Sealing & Glazing Accessories, Bonding Agents & Adhesives:

Adhesives, sealants and Glazing Accessories are products & materials often required during installation of PALSUN glazing.

Guidelines for their use, appearing below, must be followed:

1. Use only sealants, adhesives and rubber glazing strips, gaskets & sealing profiles compatible with PALSUN and approved by PALARM or its distributors.
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 PALRAM approved list must receive the Manufacturer's explicit consent, to be obtained through your local distributor.
3. Use of soft PVC gaskets and/or sealing strips is absolutely forbidden. It is detrimental and may cause severe glazing deterioration and 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 glazing and void all warranties and any responsibility of the Manufacturer for the performance of PALSUN.

Your local distributor can provide additional information, and forward materials for testing and evaluation of their compatibility with the PALSUN sheets.

The recommended list of sealants, bonding materials and adhesives could be obtained from your local PALRAM distributor on request.

13. Selection of the Appropriate PALSUN® Type for the Intended Application:

Most PALSUN family sheets are manufactured in thickness of 1.0 to 12 mm.

a. **PALTUF:** Sheets are intended exclusively for indoor use (transparent partitions, interior design applications, industrial safety shields, and thermo-formed parts for indoors use). May also be used in outdoors pavilions (exhibitions), or similar temporary structures. Use of PALTUF sheets outdoors, for permanent applications, even in areas with mild UV radiation (Northern Europe, USA, Canada and the like) is not recommended!

b. **Thin PALSUN sheets:** Frequently used in temporary structures, (exhibitions, pavilions etc.). These are often used in conservatories or other horticultural / agricultural structures, where better fit & finish are expected, along with economy and comparative low cost . Thin PALSUN sheets are repeatedly used in thermo-forming applications, where forms generated render them rigid and suitable for special requirements, in signs and other advertising elements.

c. **PALSUN sheets for Permanent Glazing Applications:**

The recommended 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 sash width of said frame, the wind/snow loads dictated by environmental conditions and building codes existing at the actual location of said structure.

Recommended Installation method is installing the glazing in fully “floating” position, clamped on its four, three or two edges, without screws or bolts through the glazing as fasteners. Other possible options could be observed further on.

d. **Regular PALSUN Glazing:** To be installed in windows, curtain-walls, upper-end skylights & sidelights in flat, sloped, horizontal, vertical or curved positions, good-quality shades & canopies, covered walkways, railway & bus stations and more.

e. **PALSUN Plus Glazing:** In outdoors applications where the glazing would be subjected to direct sunlight exposure from both sides (Sound barriers, Safety walls in sports arenas and the like).

f. **PALSUN FR:** where higher level of fire resistance is required.

g. **PALGARD** (regular, Plus & FR): Similar to PALSUN but where higher abrasion resistance & heavy-duty cleaning and graffiti removal are required. **A restriction:** Only for flat installation!!!

h. **Colors, Shades & Light Transmission:** Selected according to architectural & practical needs in standard or specially prepared variations.

PART B.

INSTALLATION INSTRUCTIONS, DIRECTIVES & RECOMMENDATIONS

CLARIFICATION: Wherever PALSUN is mentioned - PALGARD is included, unless noted otherwise.

1. Flat PALSUN® & PALGARD™ Glazing Installation on Supporting Frames. Supporting Methods & Appropriate Load Tables:

- a. PALSUN glazing should be installed, similarly to glass, in or on a supporting framework, on which the glazing would be supported on all its edges (4 sides clamped), on 3 sides or on two long edges (2 sides clamped), with or without a glazing groove, and clamped to that frame with glazing bars or profiles.
- b. PALSUN glazing could be installed, similarly to glass, in the “wet” or “dry” methods:
Basic installation procedures follow. Other variations of said methods are also used.

1) **“WET” METHOD:** A compatible polymeric putty is applied along the window sash, on all its perimeter as a base for laying the PALSUN glazing, exactly like it is done in “wet” glass installation.. Then the glazing is laid in place, leaving enough thermal expansion gaps around it. Glazing bars are then covered with same putty and installed on the perimeter, fastened to the window frame, clamping the glazing. Finally, compatible elastomeric sealing compound, (like silicone) is applied all around, inside and out, to assure window’s impermeability.

Alternate version of that method uses “dry” rubber strips or spacers instead of putty, both in the sash and on the glazing bar, as base layers, with final silicone application around glazing edges.

“Wet” method is used in wood or metal frames, in regular windows or on heavy-duty framing such as sound barriers. The method is now less popular, and the “dry” method gets to be preferred.

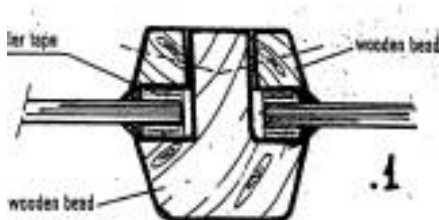


Figure 2. Typical Limited Size PALSUN “Wet” Glazing with Rubber Strip Spacers, Glazing Clamp & Peripheral Silicone Sealing Inside and Out. Illustration Depicts Sheet Steel Framing. (Right) Size is limited due to limited sash depth.

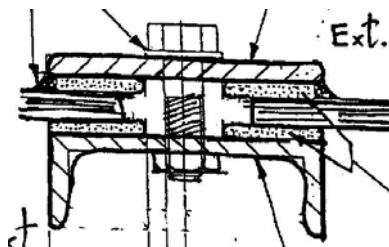


Figure 1. Typical Limited Size PALSUN “Wet” Glazing with Putty, Glazing Clamp & Peripheral Silicone Sealing Inside and Out. Illustration Depicts Wood Framing. (Left) Size is limited due to limited sash depth.

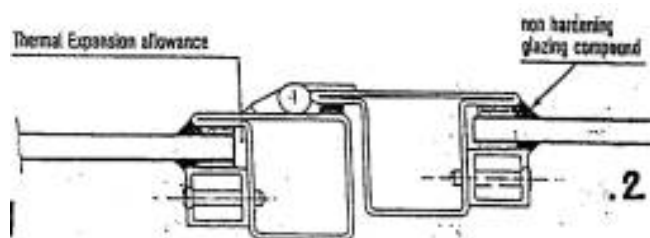


Figure 3. Typical Extended Size PALSUN “Wet” Glazing, with Rubber, or XPE Strip Spacers both sides, Glazing Clamp & external Peripheral Silicone Sealing. Illustration Depicts Heavy-Duty Steel Frame, Suitable for Large Public Structures (stadiums, sports arenas, Sound Barriers). (Right) Extended Glazing Size due to wide Engagement Dept & High Frame Rigidity .

2) **“DRY” METHOD:** Uses only “mechanical” means, such as various profiles & bars, of wood, PVC but mainly metal ones, including simple flat, bent, RHS profiles in regular steel or aluminum, or specifically designated regular & stainless steel or aluminum profiles, with specially made sealing strips & gaskets.

The method does not rely on chemical bonding or sealing of adhesive pastes and compounds of any kind. Connections, fastening and sealing are done by various types of fasteners or specially designed mechanical profiles with details enabling connections of elements by special tongue & groove design, material springiness and flexibility etc. Impermeability & sealing are arrived at by careful design & appropriate materials used, both of the rigid frame profiles and resilient rubber gaskets of many types.

Professional design circles believe “Dry” method is “cleaner” & more elegant in appearance, operates better (when designed well), more durable and longer lasting than its “wet” counterpart.

It also enables certain large-scale design options impossible or awkward to execute in “wet” systems.

Basic idea of a “dry” glazing system, either vertical or sloped (“horizontal”) is laying the glazing pane on a springy EPDM rubber or similar compatible glazing strip attached to the supporting frame along the window sash, usually on four sides, and clamp it with appropriate glazing bars or profiles, also equipped with suitable sealing strips, so those clamps tighten the glazing fully on all its perimeter, with the external gaskets squeezed tight to the glazing, sealing it against water & dirt infiltrating.

The system should be designed so that should some water succeed to penetrate this first defense line they should accumulate and drain downward through internal channels in the frame (second defense line), and should not reach the internal glazing gaskets (last defense).

This is especially important in skylights & sloped roofing, where rainwater stands more chance of accumulating & infiltrating.

Similar glazing systems exist for glass skylights & curtain-walls, all around the world, and a few could also be used for limited thickness & spacing solid polycarbonate glazing. The main requirement of any optional profile series selected is deep enough window sash which enables at least 15 to 20mm edge engagement depth plus 2-3mm gap for thermal expansion each side.

Figure 4. Typical Glazing with Simple RHS Steel Profiles & Designated EPDM rubber Glazing Strips

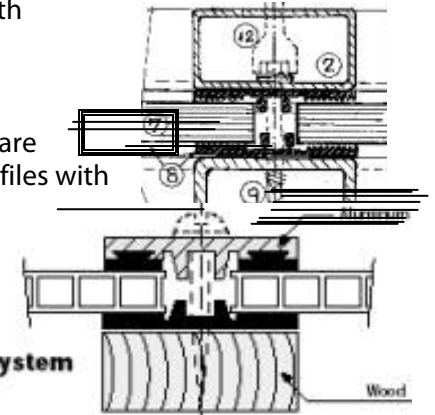


Figure 5. Typical Glazing with Combined Wood & Aluminum Profiles and Designated EPDM rubber Glazing Strips

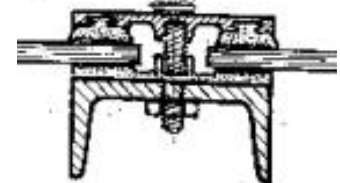


Figure 6. Typical Glazing with Heavy Duty Steel & Aluminum Profiles & Designated EPDM rubber Glazing

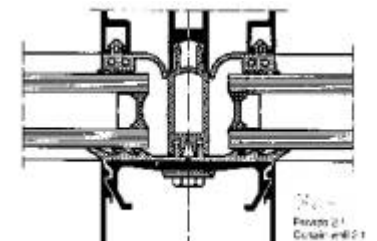


Figure 7. Existing Curtain Wall Aluminum & Glass System Optional for PALSUN Glazing of Limited Dimensions

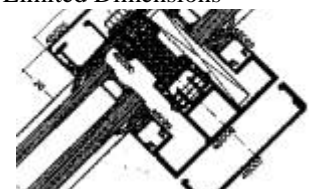


Figure 8. Existing Aluminum & Glass Sloping Skylight system Optional for PALSUN Glazing of Limited Dimensions

c. Flat Glazing Requirements according to Size, Support System & Wind/Snow Loads:

1) General Glazing Comments:

a) Shape & Dimensions Ratio:

A glazing pane can come in many shapes but most common is four-sided, generally rectangular. Ratio between rectangle's dimensions **a** (width) and **b** (length) is crucial in determining the load bearing ability of a glazing pane (or any flat, load bearing element).

Best case is when **a = b** (a square) all four glazing supported sides carry the loads equally.

Glazing rigidity & strength are optimal in both directions.

A round glazing is actually even better as it got no distant corners.

As **a:b** ratio grows smaller, (say 1:1.5) the effect of the further supports on the glazing bearing ability is reduced, until at **a:b = 1:2** the shorter sides have only negligible influence on the glazing load capacity.

From that ratio down a glazing should be considered as supported only on its two long sides and local supports at the ends reckoned only as added safety bonus.

b) Four, Three & Two Sides Clamped Glazing:

In reality a glazing isn't just supported, but clamped tightly along its edges (harnessed). Clamping adds significantly to glazing's load capacity. A glazing harnessed on all four sides has the largest load capacity.

Each decrease in clamped sides number reduces load capacity of said glazing.

Designs requiring only three or two sides clamping would need to increase glazing thickness or reduce allowed span.

c) General Load Tables Comments:

(1) Following PALSUN tables are based on a commonly accepted maximal glazing deflection, at the middle of each span under a depicted load, of 1/20 or 5% of said span. This rate, accepted for plastic glazing,, does not indicate imminent failure or break of glazing sheet.

(2) Plastics high flexibility and impact properties produce higher deflections than usual rates for glass & other conventional building materials, however such deflection rate will cause no damage to the glazing and it will return to its original position when loads are removed.

(3) Plastics high flexibility needs larger rabbet and engagement depth prepared for PALSUN glazing, assuring positive seat, preventing glazing extraction due to shortening by undue deflection.

(4) Only tables 9 & 10 (flat glazing) suits both PALSUN & PALGARD. Table 11 (curved glazing) suites PALSUN only as PALGARD should not be curved.

(5) Plastics higher thermal expansion rate requires larger allowance gap for the PALSUN glazing to assure free thermal expansion, preventing distortion & possible buckling.

(6) Other glazing details (clamping, sealing etc.) are similar to those familiar from glass, with plastics specific fitting points, as mentioned elsewhere in this guide.

(7) Data in tables is based on professional expertise, accumulated knowledge & experience, actual tests made on typical glazing panels, similarity to other products' behavior, interpolations & educated estimates.

(8) PALSUN tables begin with 4mm (5/32") thickness as lowest thickness recommended for permanent quality glazing. 1 to 3mm sheets are suitable for signs, advertising, vacuum-forming, agricultural structures, exhibitions pavilions etc.

(9) A PALSUN sheet may withstand even larger loads without buckling, but undue shortening by higher deflection may cause a pullout when the glazing edges slip out of their Supporting frame.

(10) Additional internal supports, perpendicular to main rafters or supporting arches, can add more snow-load capacity when required, while uplift wind-load remains the same. Such configuration suites heavy snow-bound areas while uplift wind forces are moderate.

This option should be calculated separately, according to pertinent conditions.

Table 9. Wind/Snow Load Chart. Flat, 4 Sides Clamped, Single Panel, Single Span.

Max Recommended Span, on Center, amid Width Supports (Shorter glazing dimension), under Progressive (light to heavy) Wind/Snow Loads, at Various Glazing Ratios:

Thickness (Gauge)		Wind/Snow Uniform Loads		Max. Support Span (Glazing Width) according to Ratio a:b					
				Ratio 1:1 to 1:1.2		Ratio 1:1.2 to 1:1.5		Ratio 1:1.5 to 1:1.8	
mm	in.	kg/m2	psf	mm	in.	mm	in.	mm	in.
4	5/32	50	10	1200	48	1150	46	1050	42
		80	15	1150	46	1050	42	1000	40
		120	25	1080	43	1020	41	920	37
		150	30	1020	41	980	39	880	35
		200	40	980	39	880	35	800	32
5	13/32	50	10	1350	54	1280	51	1200	48
		80	15	1280	51	1180	47	1100	44
		120	25	1180	47	1100	44	1020	41
		150	30	1120	45	1020	41	950	38
		200	40	1020	41	950	38	880	35
6	1/4	250	50	950	38	880	35	800	32
		50	10	1650	66	1580	63	1520	61
		100	20	1480	59	1420	57	1350	54
		150	30	1320	53	1250	50	1180	47
		200	40	1200	48	1120	45	1020	41
8	5/16	250	50	1080	43	980	39	880	35
		300	60	920	37	850	34	750	30
		50	10	2050	81	1920	77	1780	71
		80	15	1820	73	1750	70	1620	65
		120	25	1750	70	1620	65	1480	59
10	13/16	150	30	1620	65	1480	59	1320	53
		200	40	1480	59	1350	54	1180	47
		250	50	1350	54	1200	40	1050	42
		300	60	1220	41	1080	43	920	37
		50	10	2050	81	2050	81	1950	78
12	1/2	100	20	2050	81	1920	77	1780	71
		150	30	1900	76	1750	70	1650	66
		200	40	1750	70	1580	63	1480	59
		250	50	1580	63	1400	56	1320	53
		300	60	1400	56	1220	41	1080	43
12	1/2	50	10	2050	81	2050		2050	81
		100	20	2050	81	2050	81	2050	76
		150	30	2050	81	1920	75	1880	69
		200	40	1880	75	1720	69	1550	52
		250	50	1720	69	1580	63	1400	56
300	60	1550	62	1420	57	1220	49		

Notes:

1. For a glazing ratio smaller than 1:1.8 see "Table 10. Flat, 2 Sides Clamped PALSUN Load Chart".
2. Glazing table begins with 4mm (5/32") thickness as the lowest thickness recommended for permanent quality glazing. Thinner sheets fit signs, advertising, vacuum-forming, agricultural structures, temporary pavilions etc.

**Table 10. Wind/Snow Load Chart: Flat, 2 Sides Clamped, Single Panel, Single Span.
Max Recommended Span, on Center, between Width Supports, under Progressive Wind/Snow Loads:**

Uniform Load		Max. Support Distance (Glazing Width) (mm / in.)											
		PALSUN Type (mm)											
		4		5		6		8		10		12	
kg/m2	psf	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
50	10	780	31	980	39	1280	51	1800	71	1950	78	2050	81
80	16	680	27	820	33	1150	46	1680	66	1850	73	2050	81
100	20	620	25	700	28	1080	43	1550	61	1780	70	2020	80
120	25	580	23	620	25	980	39	1400	55	1700	67	1950	77
150	30	420	17	580	23	850	34	1180	47	1600	63	1780	70
200	40	NA	NA	420	17	650	26	1050	42	1480	59	1550	61
250	50	NA	NA	NA	NA	450	18	950	38	1280	51	1350	53
300	60	NA	NA	NA	NA	NA	NA	820	33	1080	43	1220	48

Note:

Preceding General Glazing Comments & Table 9. notes above pertain also for this table.



Figure 9. Typical Flat PALSUN Glazing, Skylight Canopy over Main Entrance.
ORT Technical College, Natanya, Israel.
Cold-Bent, Angled Frameless Ridge, 6mm Clear PALSUN.
PALGARD may be Used, but Bending at the Ridge will Damage Silica Coat along Bent Line.

2. Curved PALSUN® Installation on Supporting arches Supporting Methods & Appropriate Load Tables.

Table 11. PALSUN® Wind/Snow Load Chart: Curved, 2 Sides Clamped(Metric version):

Thickness	Sheet Curvature Radius	Max. Recommended on Center Distance between Supporting Arches according to Wind/Snow Loads Below (mm)							
		Uniform Wind/Snow Loads (kg/m ²)							
mm	mm	50	80	100	120	150	200	250	300
4	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	
5	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
6	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	
8	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
10	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
12	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 page 23



Table 11a. PALSUN® Wind/Snow Load Chart: Curved, 2 Sides Clamped, (US Customary Version):

Thickness		Sheet Curvature Radius		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	4	28	2 1/3	81	81	81	81	81	75	69	63
		36	3	81	81	73	65	59	53	48	40
		44	3 2/3	81	75	69	63	57	50	42	36
		52	4 1/3	77	71	65	58	52	47	40	36
		59	5	71	65	59	54	48	42	36	36
		71	6	65	62	56	52	45	38	33	28
		79	6 2/3	62	58	53	50	42	35	30	26
		87	7 1/3	59	55	51	47	39	32	27	24
		110	9 2/3	53	50	47	44	36	29	24	NA
158	13 1/6	48	42	38	34	31	26	18	NA		
236	20	34	31	29	26	24	18	NA	NA		
13/64	5	36	3	81	81	81	81	81	81	75	69
		44	3 2/3	81	81	81	81	81	75	69	63
		52	4 1/3	81	81	81	81	77	69	63	57
		59	5	81	81	81	77	73	67	61	55
		71	6	81	81	77	73	69	61	53	46
		79	6 2/3	81	77	73	69	61	53	46	42
		87	7 1/3	77	73	69	65	59	51	44	40
		110	9 2/3	63	59	55	51	48	42	36	30
		158	13 1/6	55	51	48	44	40	34	30	20
236	20	48	42	38	34	30	20	450	NA		
1/4	6	44	3 2/3	81	81	81	81	81	79	75	69
		52	4 1/3	81	81	81	81	81	75	69	63
		59	5	81	81	81	81	75	69	63	57
		71	6	81	81	81	77	71	65	59	53
		79	6 2/3	81	81	77	73	67	61	55	50
		87	7 1/3	81	77	73	69	65	59	53	48
		110	9 2/3	67	63	59	55	51	46	40	34
		158	13 1/6	63	59	55	51	46	40	34	29
		236	20	58	54	51	48	43	37	31	21
5/16	8	59	5	81	81	81	81	81	75	69	63
		71	6	81	81	81	81	77	71	65	59
		79	6 2/3	81	81	81	79	75	69	63	57
		87	7 1/3	81	81	81	77	73	67	61	55
		98	8 2/3	81	81	76	73	68	62	56	50
		110	9 2/3	81	77	72	68	63	57	51	46
		158	13 1/6	77	72	68	64	59	53	48	40
		236	20	72	66	60	54	50	44	38	31
13/32	10	71	6	81	81	81	81	81	77	71	65
		87	7 1/3	81	81	81	81	79	73	67	61
		110	9 2/3	81	81	81	77	71	69	63	57
		158	13 1/6	81	81	79	75	70	64	58	52
		236	20	81	76	72	68	61	55	50	44
1/2	12	87	7 1/3	81	81	81	81	81	81	77	71
		110	9 2/3	81	81	81	81	81	77	71	65
		158	13 1/6	81	81	81	81	77	71	65	58
		236	20	81	81	81	77	68	62	56	51

See notes next page

Notes for Tables 11 & 11a:

1. PALSUN glazing sheets should be installed with their curved edges sustained on the supporting arches, with 15 to 25mm ($\frac{5}{8}$ "-1") edge engagement, depends on span, plus 2-3mm ($\frac{3}{32}$ "- 1/8") thermal expansion gap.
2. Thin sheets (up to 6mm or $\frac{1}{4}$ ") could be bent as relatively short glazing panels, 2.00 to 3.00m at 1000-1220mm width (6'7" to 10' length, at 40" to 48" width). Thick sheets of 8mm (5/16") and up could be cold curved only as special order long panels (4.00 to 7.00m or 13'2" to 23' long) particularly when installed in full 2050mm (6'9") width or close.
3. Supporting arches & clamps should withstand total maximum permitted loads without difficulty.
4. Spans less than 500mm (20") are generally impractical for such installation method.
5. Lowest radius value depicted is minimal permitted radius for that specific PALSUN sheet.
6. Depicted 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.



Figure 10. Typical Curved PALSUN Glazing, Skylight Canopy over Main Entrance to Office Building & Shopping Arcade.
Cold-Curved, 6mm Clear PALSUN.
PALGARD Should not be Used as Curving would Damage the Silica Coat.

3. General Indications for Curved PALSUN Installation:

a. **Clamping:** Curved PALSUN glazing should be installed almost identically to flat installation, similarly to glass, in or on an arched supporting framework, on which the glazing would be supported, adapted & clamped on two or four of its edges, with or without a glazing groove. The clamps (glazing bars or profiles) should also be curved by simple hand pressure (in simple, shallow curves) or by designated roll-forming in deep curves and/or complex profiles.

b. **“Wet” or “Dry”?:** PALSUN curved glazing could be installed similarly to flat glass or PALSUN, in “wet” or “dry” methods. Basic installation procedures and details are shown on the flat PALSUN installation previously depicted. Variations of said methods are also used.

c. **Stronger when Curved!:** PALSUN, like any sheet shaped material, gets stronger & more rigid when it is curved. Strength and rigidity increase as the PALSUN sheet curve (“radius”) nears the minimal permitted bending radius (deepest allowed curve), as can be observed in the curved glazing load table.

d. **Minimal Curving Radius:** Essentially, PALSUN minimal permitted curving radius is calculated as 175 times the sheet thickness. This rate was arrived at after a careful testing, which showed that at this minimal radius the sheet isn’t damaged and still retains its typical properties. A sheet could be bent to an even smaller radius, but undue internal stresses created by excess curving would lead to crazing, fracture & eventual failure.

e. **“Cold” Vs. Thermal Curving”:** All the above refers to “cold” curving, i.e. forming the sheet at average ambient temperature by forcing it to a curved shape relying on polycarbonate’s natural flexural properties.

PALSUN glazing could be curved to an even smaller radius by a thermo-forming process without any ill-effects of excess stresses. A costly procedure limited by size & availability of required thermoforming equipment.

f. **Spring Back:** Cold curved PALSUN is springy, pushing back trying to retain its original shape. The thicker and shorter the sheet the more difficult it is to bend it and keep that shape. This must be taken into consideration both at the design and at execution stages. Proper structural framework and glazing bars should be selected to withstand the loads.

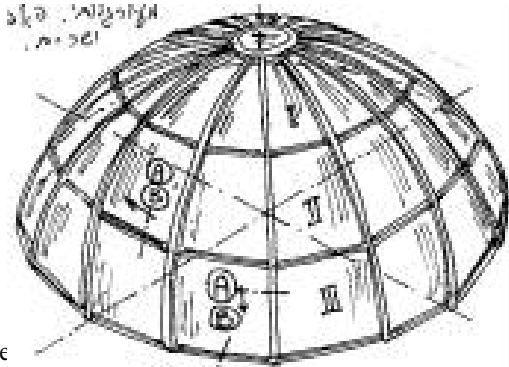


Figure 11. Sche Sketch of PALSUN Glazed Dome Skylight



Figure 12. Diagonal Look through Curved PALSUN Vaulted Walkway

4. Directives, Instructions & recommendations for Flat & Curved PALSUN® Glazing:

a. Rabbet Depth:

Depth prepared for glazing engagement (e) plus half of the expansion gap ($\frac{1}{2}f$). It is the whole depth prepared in the frame for glazing installation. Rabbet depth grows as glazing width grows.

Table 12 below depicts edge engagement (e) dimensions respectively to glazing width. PALSUN edge engagement is larger than glass because of its higher flexibility & deflection, which might generate glazing fallout through shortening due to excess deflection.

b. Thermal Expansion Gap:

Next Table 13 exhibits recommended gap for thermal expansion according to glazing pane length. Half that gap is to be provided all around the glazing but it really is nil at the bottom and full at the top. Gap required is also wider due to polycarbonate higher thermal expansion coefficient.

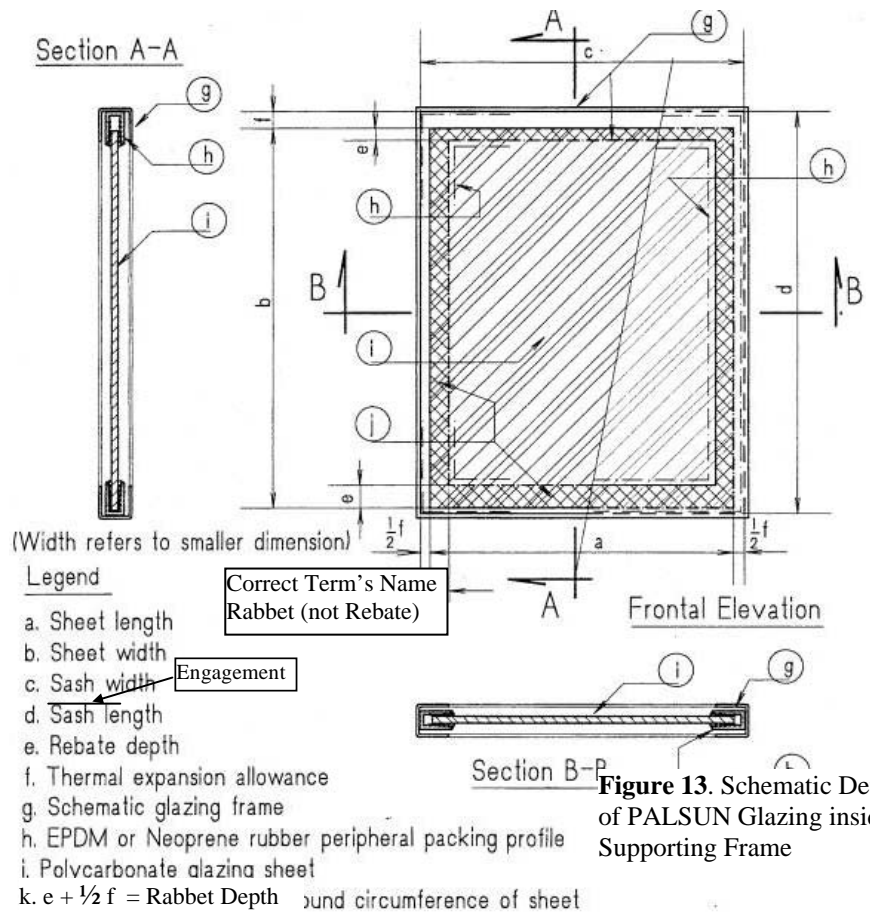


Figure 13. Schematic Details of PALSUN Glazing inside A Supporting Frame

Table 12. PALSUN Glazing Rabbet Depth Width according to Width & Thickness of PALSUN Glazing

(a) PALSUN Glazing width		(t) Glazing Thickness		(e+ 1/2 f) Rabbet Depth	
mm	in.	mm	in.	mm	in.
Up to 700	Up to 28	3	1/8	15 - 20	39/64 - 13/16
701 - 900	28 - 35	4	5/32		
901 - 1100	35 - 43	5	13/64		
1101 - 1300	43 - 51	6	1/4	20 - 30	13/16 - 1 1/4
1301 - 1500	51 - 59	8	5/16		
1501 - 1700	59 - 67	10	13/32		
1701 - 2000	67 - 79	12	1/2		

Table 13. Thermal Expansion Gap for PALSUN Glazing according to Length

PALSUN Glazing Length (b)	mm	300-700	701-1000	1001-1300	1301-1700	1701-2000	2001-2500	2501-3000
	ft.	1-2.35	2.35-3.35	3.35-4.35	4.35-5.70	5.7-6.70	6.70-8.20	8.20-10
Expansion Gap (f)	mm	2	3	4	5	6	7	8
	in.	5/64	1/8	5/32	13/64	1/4	9/32	5/16

Note: As a rule of thumb, an inclusive gap of 1mm is required for every 300-400mm of sheet length. Half this gap should be left at both width sides, while a whole gap provided at top length side and nil at the bottom.

c. PALSUN® Installation in a Partial Frame:

PALSUN could be installed clamped on three sides and frameless on the fourth (generally top), and even clamped on two sides only. This situation requires a thicker, more rigid glazing pane than that installed in a full frame. Rate of thickness increase is to be determined along 2 parameters: glazing size (particularly width) and maximal anticipated wind-loads. Such a method is usually used in vertical installations, many times in sound barriers.

d. Fastening PALSUN® with Bolts, Screws or Rivets:

A possible option, even if not truly recommended. Installed in or on a supporting frame with bolts/screws through pre-drilled oversize holes in the PALSUN sheet.

- 1) Holes would be 2mm larger in diameter than bolt or screw used, to enable thermal expansion.
- 2) Each bolt/screw would be equipped with a $\varnothing 30-40\text{mm}$ rigid metal (stainless/aluminum) washer, with a compatible shaped soft EPDM gasket under the bolt head, on top side of the glazing, to distribute the bolt's pressure and pad the fastener's surrounding. (fig.15)
- 3) Tightening should be controlled & carefully executed, avoiding excess local pressure on the glazing and distortion of the gasket. **Under no circumstances would an impact wrench be used for the job.**
- 4) A minimal distance of 2.5 times bolt/screw diameter, from glazing edge to nearest hole edge, would be maintained, never less than 12mm.
- 5) Bolt fastening with pressure distribution clamping bars, with compatible EPDM strip should be preferred over fastening with separate oversize washers. (Fig.16)
- 6) Fastening with bolts/screws would be selected, mostly, in projects where sheer strength of fastening has an obvious preference over appearance, or when full length clamping profiles may interfere with proper rainwater drainage (shallow angled overhead skylights or roof glazing. Fig. 17).

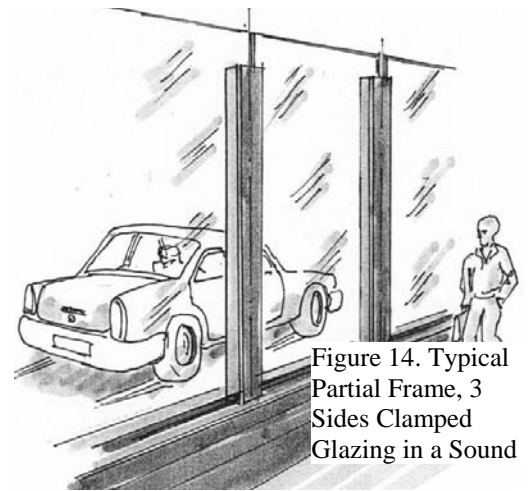


Figure 14. Typical Partial Frame, 3 Sides Clamped Glazing in a Sound Barrier

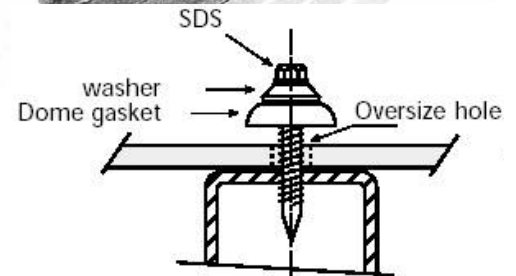


Figure 15. Basic Screw Fastening with Separate washers. Under the Glazing a Thin EPDM Strip Padding

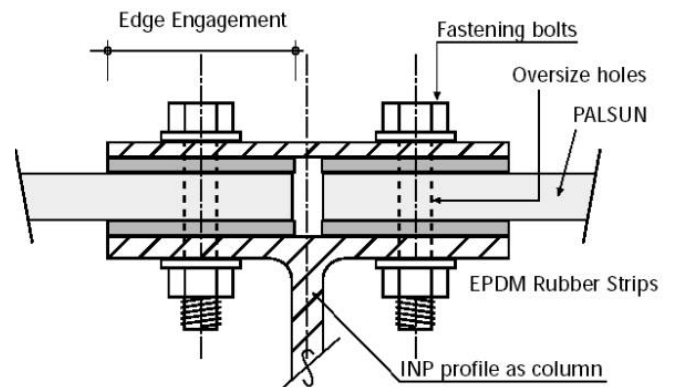


Figure 16. Typical Heavy-Duty Pressure Distributing Bar Clamped Glazing, with Bolts Fastening, in a Sound Barrier

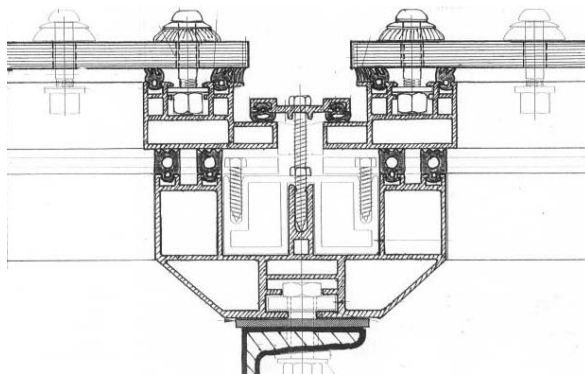


Figure 17. High-End, Heavy-Duty Aluminum Sub-Frame with Separate Bolts & Washers Fastened Glazing in a Variable Slope, Very Shallow in Parts, New Olympic Stadium Roof, Athens 2004 (Left)

e. Indications for Design & Execution of PALSUN Glazing Supporting Frames:

1) PALSUN safety Glazing as Glass Replacement in Existing Window Frames:

PALSUN glazing could be installed in conventional residential housing wood, steel or aluminum doors & windows, or subdivided ones used in schools and educational facilities, replacing fragile and unsafe glass panes. Old-fashioned fenestration it is usually glazed by the “wet” method, with sealing paste & compatible putty, while recent types are almost certain to be of the “dry” type. Limited rabbet depth suffices for the relatively small sized conventional windows.

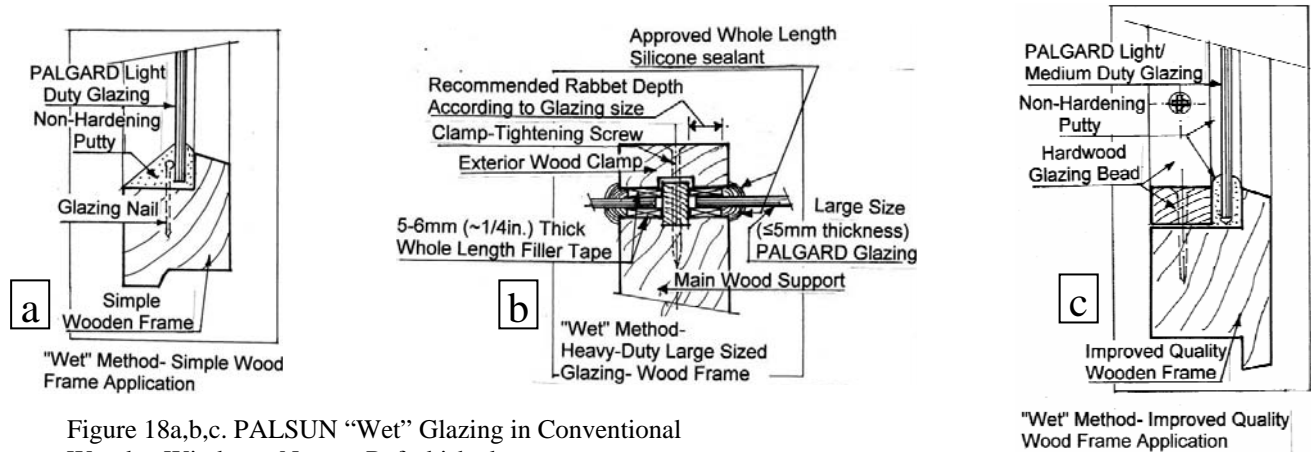


Figure 18a,b,c. PALSUN “Wet” Glazing in Conventional Wooden Windows, New or Refurbished.

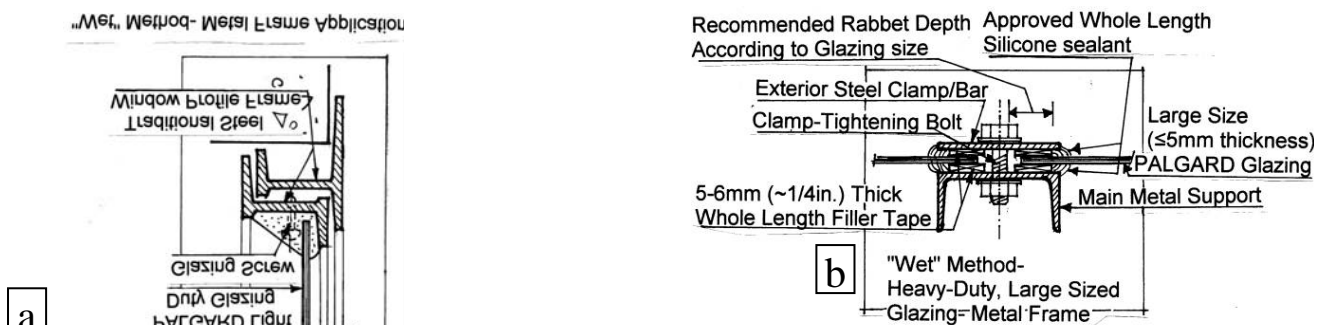


Figure 19a,b. PALSUN “Wet” Glazing in Conventional Steel Windows, in Light & Heavy Duty Versions, New or Refurbished.

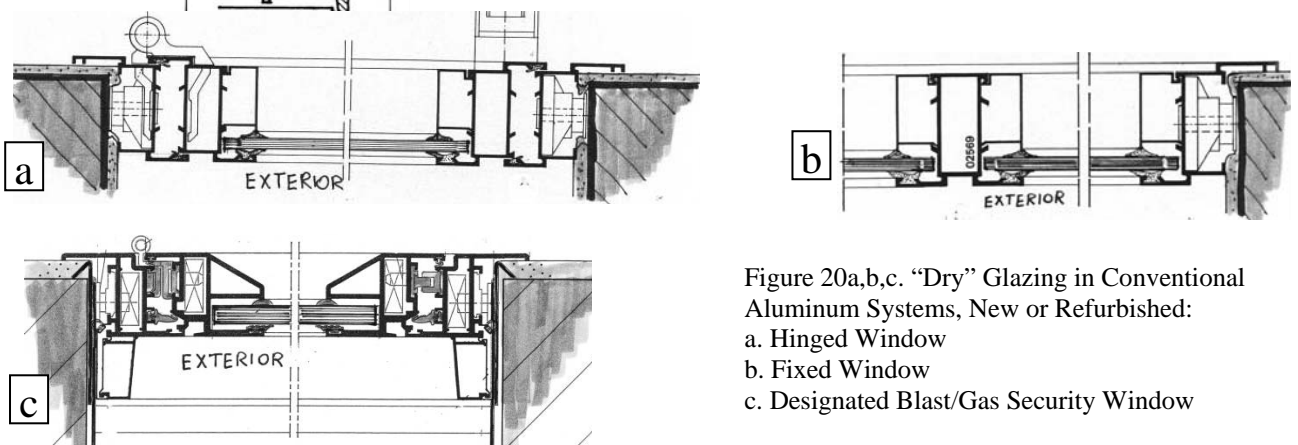


Figure 20a,b,c. “Dry” Glazing in Conventional Aluminum Systems, New or Refurbished:

- a. Hinged Window
- b. Fixed Window
- c. Designated Blast/Gas Security Window

2) PALSUN Safety Glazing in See-Through Sound Barriers:

Supporting frames in such barriers, erected along noisy main roads & highways, around and inside sports arenas & stadiums, or near similar boisterous facilities, are mostly heavy duty structures, designed to withstand possible brushing with road vehicles or unruly crowds. Such framework is mostly made of heavy weather protected steel elements, with suitable detailing as mentioned above.

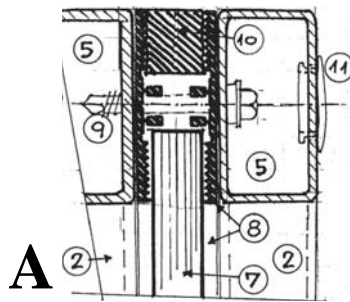


Figure 21A. Top, Bottom & Side Cross Section Detail (A), RHS Back-Support & Clamp + Spacer

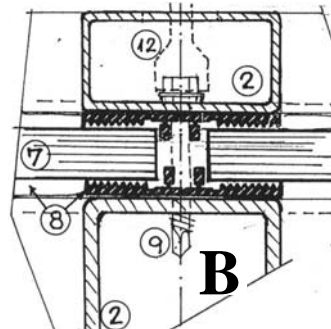


Figure 21B. Vertical Mid-Post Cross Section Detail (B), RHS Back-Support & Clamp

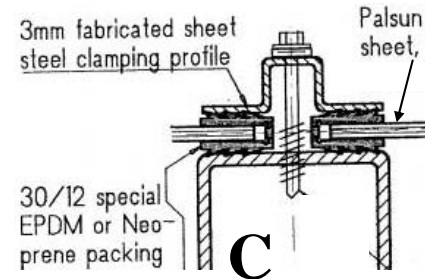


Figure 21C. Vertical Mid-Post Cross Section Detail (B), RHS Back-Support & Fabricated Clamp

Legend:

- W (Net Glazing Width) < 2050mm
- h₁ (Base Wall Height) By Design
- h₂ (Net Glazing Length) < 6000mm
- 1) Concrete Base Wall
- 2) Vertical Structural Post
- 3) Noise Source Side
- 4) Noise Reduction Side
- 5) Top Level Support & Clamp
- 6) Bottom Level Support & Clamp
- 7) PALSUN Acoustic Glazing
- 8) PALRAM EPDM Dry Glazing Strip
- 9) Fastening Bolt & Nut (or SDS Screw)
- 10A) EPDM (or suitable other) Spacer
- 10F) Bottom Bent Steel Structural Sill.
- 11A) Plastic Stopper for Fastener Hole.
- 11F) EPDM Bottom Glazing Spacer
- 12B) Indicated Socket Entry for Fastening.
- 12F) Steel Insert in Concrete Base Wall.

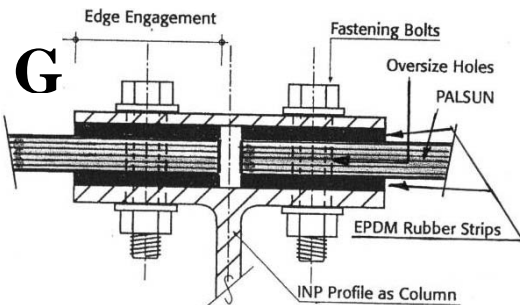


Figure 21G. Vertical INP/HEB Mid-Post, Cross Section Detail (B), with Bolted-On Clamp.

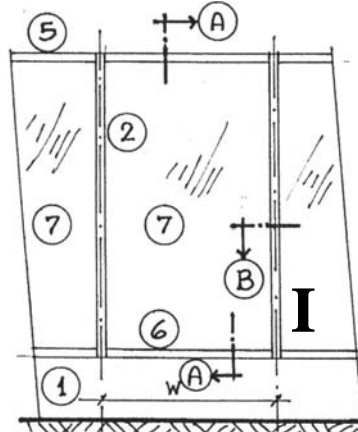
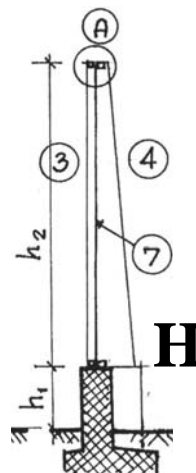


Figure 21H,I. Typical Façade Segment & Vertical Cross Section of a See-Through PALSUN Glazed Acoustic Barrier

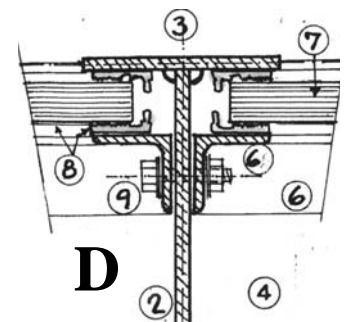


Figure 21D. Vertical Fabricated Mid-Post Cross Section Detail (B), with Bolted-On Back-Clamps.

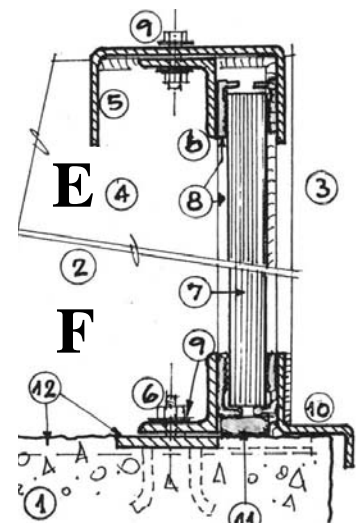


Figure 21E,F. Top, Bottom (& Side) Cross Section Detail (A), Fabricated Supports & Bolted-On Back Clamps

3) PALSUN Glazing in curtain walls, skylights & sidelights:

Supporting Framework Options:

a) **Wood:** Heavy Duty Rectangular section beams, girders, joists & rafters of all sizes & wood types, with appropriate EPDM glazing strips and durable, weather resistant finish. Typical glazing bar and support beam section width about 60 mm. Section height as required by design.

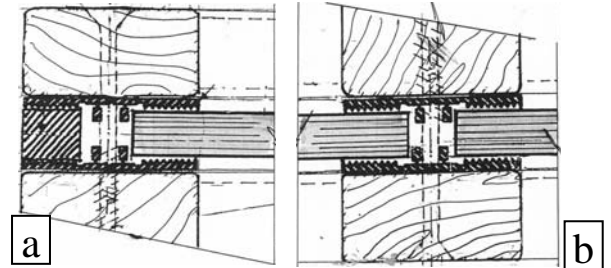


Figure 22a,b. Heavy-Duty Wood Frame & PALSUN Glazing.
a. Side-Support with Side Spacer.
b. Mid-Support with Glazing both sides

b) **Plain steel or aluminum:** Heavy-duty standard elements such as RHS or L, H & U professional profiles of varied shapes, size & thickness. Typical glazing bar and support beam section width about 60 mm. Section height as required by design. Equipped with appropriate EPDM glazing strips and durable, weather resistant finish.

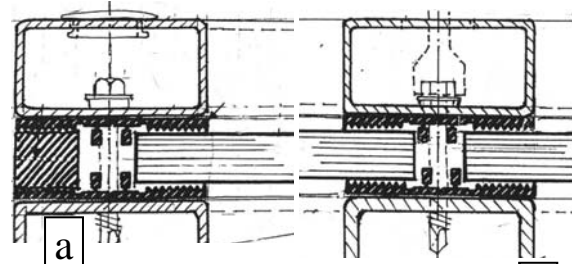


Figure 23a,b. Heavy-Duty Metal Frame & PALSUN Glazing.
a. Side-Support with Side Spacer.
b. Mid-Support with Glazing both sides

c) **Hybrid Systems:** Joint efforts by mixed frame components as steel or wood support structure & assigned aluminum glazing profile. Internal support structure gets 60mm wide EPDM glazing strip bonded to its front and the external clamping bars get designated small shaped EPDM sealing strips

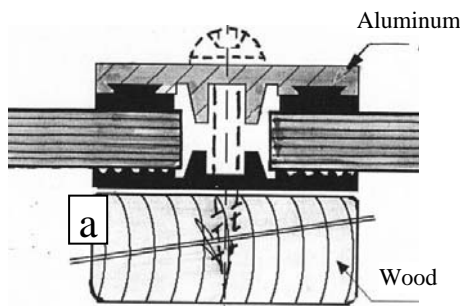
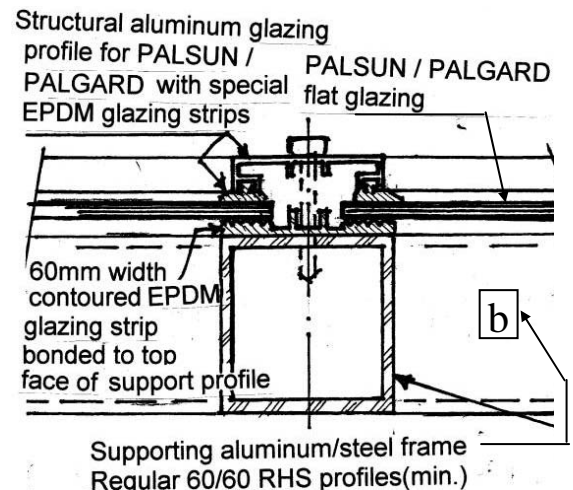


Figure 24a,b. Hybrid System Frame Components & PALSUN Glazing.
a. Wood Support & Aluminum Clamp.
b. Steel Support & Aluminum Clamp.



d) Existing Glass Oriented Curtain-Wall Profile Systems in PALSUN Glazing:

Existing high-end glass oriented designated systems for public or office buildings, for PALSUN glazing of up to 1200mm, due to limited (up to 20mm) rabbet depth. Suitable profile series, mostly in aluminum but some in stainless steel, are available from many suppliers all over the world. Only systems of 55mm profile width and more, with at least 20mm rabbet depth, should be considered.

Depicted below are two typical aluminum curtain wall systems, from two separate sources, with identical width and similar details. There are differences though in rabbet depth as the German system (a) gets better thermal insulation (thermal bridge), as it is intended for a much colder climate.

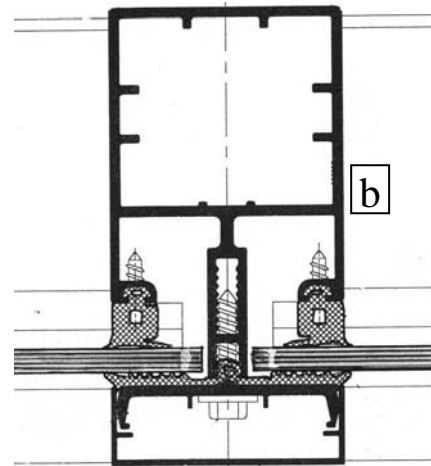
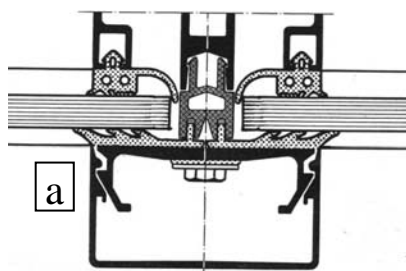


Figure 25a,b. Existing Curtain Wall/Skylight Aluminum Systems & PALSUN Glazing.
a. A Typical System of German Origin.
b. A Typical System of Israeli Origin.

Existing heavier duty systems, upgraded versions of the formerly mentioned series, are wider by design (about 70mm), but their rabbet depth is enlarged only by 3-4mm, so the wider profiles can sustain wider PALSUN glazing but less than might be anticipated by the larger profiles.

e) Existing Multi-Wall Oriented Systems:

Multi-wall oriented aluminum profile systems prepared for improved quality flat polycarbonate multi-wall sheets, may suit PALSUN glazing too. However these systems offer relatively light gauge profiles. They could be used only in light to medium duty requirements, as they need additional supportive sub-structure under or behind to withstand higher loads.

These systems should not be selected for use in installations with loads higher than 150kg/m² or where glazing thicker than 6mm is required. The profiles would warp under the heavy loads or by the forceful pressure of the heavy glazing edges.

In most cases these systems suit both vertical or sloped (leveled) installations, as a part of the existing profiles is prepared with internal drainage channels and even condensation water collecting gutters.

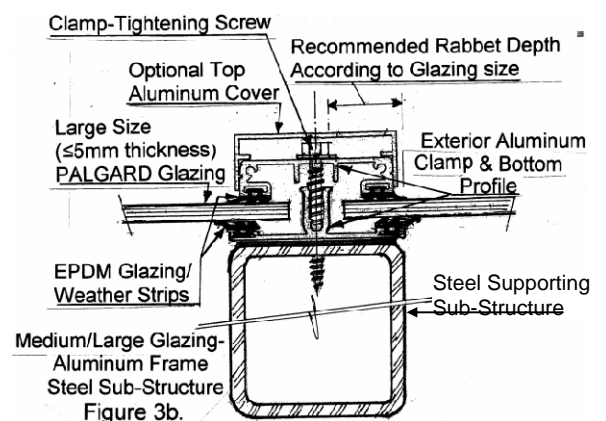


Figure 26. Existing Flat Multi-Wall Aluminum Profile Glazing System with Steel Supporting Sub-Structure

e) Specialized Systems for Polycarbonate Glazing:

Particularly designated profile systems for use with solid polycarbonate glazing are produced by (or for) contractors specializing in polycarbonate glazed structures. These series offer deeper rabbet depth and are produced in heavy gauge suitable for the thickest PALSUN sheet and relatively heavy loads, intended for specially shaped, high-end public & office buildings. Such profiles are not freely available for purchase, and could be acquired only as parts of complete projects. Such profiles are usually more elaborate and may offer additional properties as external condensed vapor drainage systems for skylights as well as internal channeling solutions for rainwater infiltration.

Profile illustrated on Fig. 27 can be used either as vertical post or as overhead skylight support girder, as it has internal channeling for infiltrated rainwater.

Profiles fitted with external condensation water drainage systems are more suitable & efficient for overhead skylights, as they provide extra protection from cold drippings from above.

Any of these options would require specific accessories like designated EPDM glazing profiles of specific shapes to fit the intended purposes and profile, along with the more common compatible silicone sealant, self-adhesive sealing & spacing strips etc. required for these types of structures.

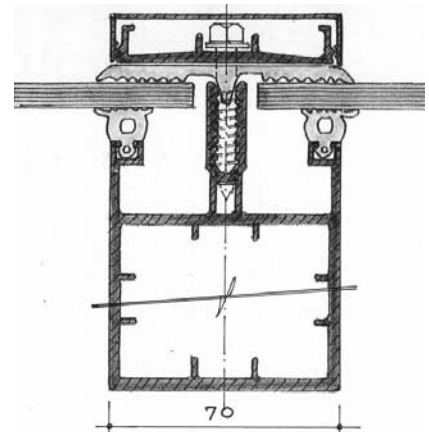


Figure 27. Typical Heavy-Duty Aluminum Profile of a Specialized Glazing System, Generally meant for Vertical Installation.

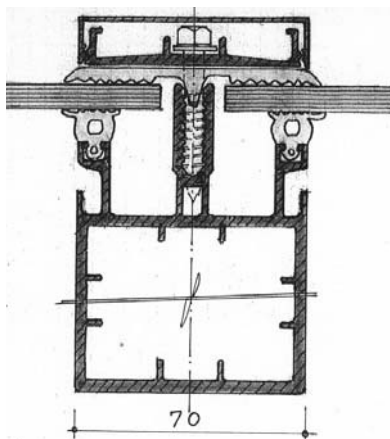


Figure 28. Heavy-Duty Aluminum Profile for Specialized Glazing Systems, Equipped with External Condensation Channeling.



Figure 29. Heavy-Duty PALSUN Glazing & Specialized Aluminum System with External Condensation Channeling on a Vaulted Skylight over a Shopping Mall.

5. Principles of Planning & Engineering Design with PALSUN® Glazing:

a. Color, Tint, Light & Heat Transmission:

Almost any color & tint, in any rate of light transmission and thickness (up to 12mm) could be obtained , subject to minimal quantity order. In relatively small quantities only standard colors & light-transmission rates could be supplied, subject to production runs availability & date.

b. Standard & Custom Sheet Dimensions:

Normal PALSUN sheets could be obtained in 3 standard dimension (in mm): 1250 x 2050, 1220 x 2440, 2050 x 3050. in relatively small projects these are the basic sizes the glazing panes should be derived from, preferably with minimal or no waste.

In large scale PALSUN projects it is possible to order sheets of at any required dimensions, **up to 2050mm width**. Any length up to 12.00m could be obtained. However due to polycarbonate higher thermal expansion rate we recommend the use of sheets **no longer than 6.50 to 7.00m**.

c. Forming PALSUN Glazing:

Important Note: This specific paragraph refers only to PALSUN. Currently available PALGARD sheets should not be bent or curved, as these acts may break or damage the abrasion resistant silica coat!

1) Cold Forming:

a) Unlike glass, PALSUN glazing could be formed to a desired shape quite easily, by “Cold Curving”, relying on PALSUN glazing’s natural flexibility, subject to minimal bending radius suitable to the specific sheet thickness, or by “Linear Cold Bending”, using a mechanical “Brake Press” bending machine, similar to the one used to bend flat sheet-metal.

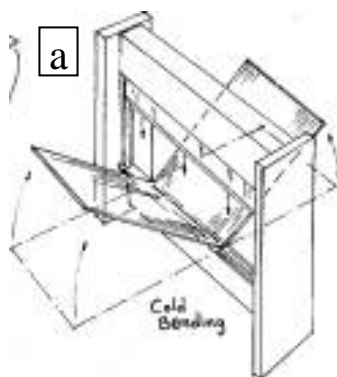


Figure 31 a,b. Cold Bent PALSUN Glazing
a. Linear Cold Bending Process (Top)
b. Linear Cold Bent Glazing in a Skylight (Bottom)

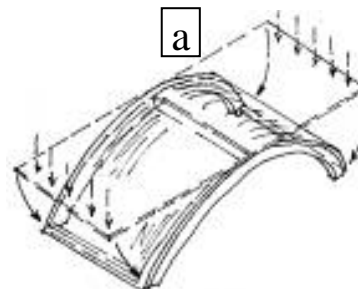
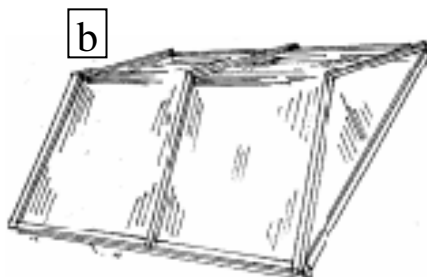


Figure 30 a,b. Cold Curved PALSUN Glazing
a. Cold Curving Process (Top)
b. Cold Curved Glazing in Skylights (Bottom)



- b) Linear cold bending could be used for forming a frameless ridge in a two-way sloped skylight, or similar project getting clean one piece glazing running both ways. (Fig. 9, Fig.31a,b.)
- c) It should be noted that linear cold bending requires knowledge & expertise in processing plastics, while cold curving is relatively simple and easier to perform with less experienced workers.
- d) Detailed “Cold Curving” & “Linear Cold Bending” processing information is available at PALSUN Fabrication chapter.

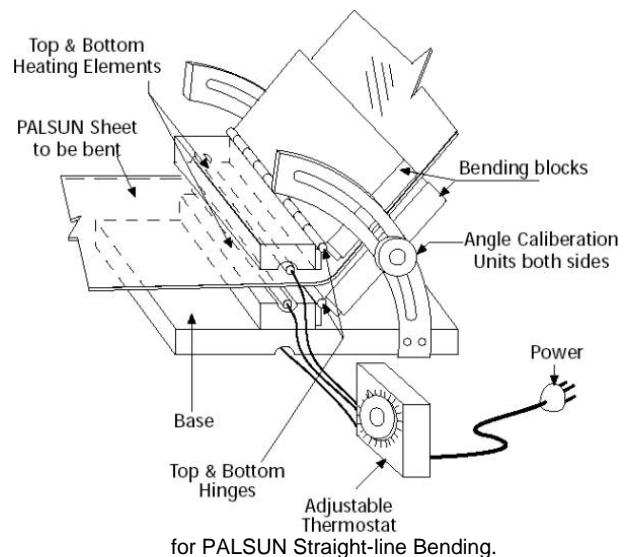
2) Thermoforming:

- a) PALSUN sheets can be quite easily fabricated by thermal processing. There is a special PALSUN type designated specifically for thermal processing, equipped with special heat resistant masking films, able to withstand the temperatures required for polycarbonate processing. This sheet requires no special preliminary treatment and can be fabricated with its protective masks on, which protects the prepared sheet from damage during further handling & installation.
- b) A regular PALSUN sheet requires, in most cases, peeling-off the masking on both sides prior to a drying process in a special oven to get rid of the moisture content in the sheet. A thermoforming process without pre-drying would lead to bubbles and internal irregularities in the sheet created by the evaporation of the water content under the over 100°C temperatures required by the process.
- c) The simplest fabrication, requiring no pre-drying, is “Linear Thermal Bending”. In this process the sheet is heated from one or both sides (depending on sheet thickness) by linear electric heating elements, until the bending area reaches the proper temperature (110-120°C) and softens. Then the sheet is bent along the desired line to the required angle and left to cool down.

It is preferable to perform such bending in a special bending device, enabling a clean and accurate bending in direction, measurement and bending angle. (Fig. 32 right)

do not place the sheet too close to the heating elements, for fear of scorching and meltdown.

It is possible to perform a few sequential linear bends on the same sheet to achieve special angles & shapes.



- d) Another thermoforming method enables bending a flat PALSUN sheet into an arched form smaller in radius than possibly allowed by “cold curving”.

The sheet is “baked” inside a suitable oven to the required temperature until it softens, then taken out and placed, quickly, over a prepared mold where it “drapes” down on the round mold, with possible assistance of careful hand pressure pushing both ends towards the mold, and held there for a few seconds until it cools a little and retains its desired shape.

A variation of that method uses an oven large enough to contain both the necessary PALSUN sheet and the suitable heat resistant round mold with wheels. The sheet is placed on top of said mold and pushed into the oven, where it “bakes” and eventually drapes down due to its own weight. After a fixed period, arrived at by experience, it is taken out, given last finishing touches by hand and left to cool down.

e) Other PALSUN thermoforming procedure use various methods, sometimes integrated with each other, based on heating and forming in molds under mechanical pressure, compressed air or suction (vacuum-forming). They enable creating 3 dimensional glazing panels, much tougher and rigid than their basic thickness may suggest. It enables preparation of skylighting domes, canopies, roof or wall glazing panels of thinner material at lower cost

Figure 33. Small Household Greenhouse Clad with Thin-Walled Vacuum-Formed PALSUN panels



d. Basic Guidelines for Correct Design & Application of PALSUN Glazing:

1) General Comments:

a) PALSUN at all variations is an excellent glazing material for different applications of glazing and light-transmitting cladding. Careful design and implementation according to Manufacturer directives, recommendations and installation instructions would lead to many years of satisfying service.

Disregard of Manufacturer design directives & recommendations and careless or indifferent follow-up of the installation instructions may lead to faulty function, failings & damages. Breakage and eventual failure, and a substantial reduction in glazing endurance.

b) PALRAM Tech-Support department will supply the designers with state-of-the art professional assistance and consultation during all stages of design and preparation of necessary specifications for tenders, and further direct & instruct said designers, project managers and supervisors how to oversee the main & sub-contractor's form and quality of execution.

2) Basics for Design:

a) **PALSUN Thickness:** Sheet thickness would be determined according to glazing design, supporting frame, glazing spans and local engineering codes for wind/snow loads, and/or from special man-made reasons (crowd swarming, vandalism or violence), as appears elsewhere in this guide.

b) **Prevention of Mechanical damage:** Regular PALSUN is softer than glass, even if much more impact resistant. PALSUN surface might be damaged from hits, mechanical strikes, abrasive and polishing substances, cleaning tools & accessories, even those which do not chemically attack the polycarbonate glazing.

We Recommend:

- **PALGARD:** Whenever such conditions are anticipated, and the design allows it, use PALGARD sheet for better mechanical surface resistance.
- **Obstacles for Vandals:** When possible, prepare in the design a barrier or obstacle creating a gap wide enough to prevent or interfere with a direct damaging contact between a probable assailant and the glazing.
- **Maintenance & Cleaning:** Prepare in advance clear and easily recognizable signs with proper instructions for the recommended Maintenance & Cleaning.

c) **Control of Light & Heat Transmission:** Colorless transparent PALSUN (Clear) or tinted transparent sheets of all variations are handsome and aesthetic, transmit a lot of light and it is possible to enjoy the scenery and clouds in the sky by day and the moon and stars by night. lovely.

However, these nice properties create a problem, especially in warm and hot climates, for along with the lot of visible light ample amount of heat finds its way through the glazing to the building interior.

This bothersome heat enters the building mostly as direct radiation and even strong air-conditioning could not get rid of the inconvenience and possible damage to inhabitants and hardware.

This surplus heat puts a heavy load on the building air-conditioning system, if exists, especially around the transparent area, increasing energy requirements and maintenance cost substantially.



We Recommend:

- In warm to hot climates, or in those climates where summers could be hot, when the architect is adamant on using transparent glazing, then reducing glazing size to a possible minimum, to diminish heat buildup and amount of direct heat radiation, is a preferred option.
- Designing the overhead skylights and other glazed openings so most of them would be shaded all or most of the day by other parts of the building, or locating them so they would be Northern oriented as far as possible.
- When the design approach is a practical and reasonable approach, aluminum gray “**Solar Control**” or the pearly white “**Solar Ice**” PALSUN glazing should be selected, as they transmit only 20 to 35% of the visible light with even less percentage of direct heat radiation, while still offering a small amount of optical transparency.

These metallic hues are both aesthetic and “Hi-Tech” in appearance, providing a reasonable amount of light-transmission while transmitting significantly lower percentage of heat.

Another option: Opal-White glazing, transmitting no direct radiation, reflecting back most of the IR heat radiation.

There is not any optical transparency, but it provides controlled transmission of indirect “white light”, combining the full range of the rainbow colors.

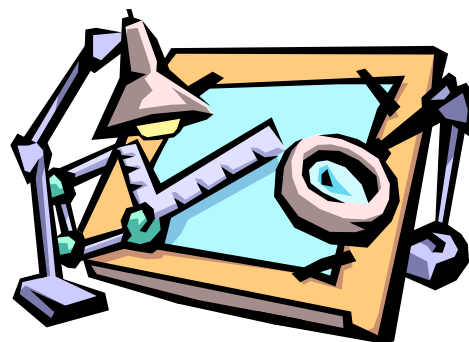


Figure 35. PALSUN Clad Moveable Skylight in Opal-White Curved Glazing

d) **Design & Engineering:** Basic design, prepared along the main creative design ideas, should take the guidelines, directives and recommendations in this manual as a part of said design. Further ideas and particular design impressions could derive from our PALSUN projects album, available from our professional CD or from our Website: www.palram.com

We Suggest:

- When using solid polycarbonate glazing in a project is considered, the designer should, after studying the available technical & informative literature, prepare a conceptual program and get in touch with PALRAM Tech-Support department for preliminary assistance & consultation. This first step could be done by mail, fax, and e-mail or by phone.
- As a second step, the designer would send, by fax, e-mail or special delivery, primary sketches and schemes describing the design or rough ideas of the intended project, preferably with complementary text description or interpretation of the project objectives, possible questions or conflicting ideas. PALRAM Tech-Support consultant would respond within a short time, and would pass on various information and primary technical details by same means, to get the project on its way. If the need arises, an actual face-to-face meeting could be quickly arranged.
- As the general planning & design advance further, the designer would send these advanced plans, yet in raw stage, to PALRAM consultant, for scrutiny & comments, and for more advanced consultation and directives towards the Special Tender & actual details and execution plans preparations.
- When the final tender documentation & execution plans are at last stages, the designer/engineer or project manager would pass on those documents to PALRAM consultant for final scrutiny & comments, if any.



e) **Professional Design Tips:**

1) **Reasons & Arguments for the Use of Flat PALSUN Glazing:**

- Possible application in almost level positioning, with minimal pitch, depending on geographic location and local climate conditions or vertically.
- Can be used in whole roof cladding or skylights of all kinds, or in windows, sidelights and various types of curtain-walls. See fig. 36 for two schematic samples.
- Basically is easier to apply, in many types of supporting framework. Can be installed in wood, steel or aluminum structures, or a combination of these materials. Enables simpler & more reliable finish from impermeability standpoint.
- On the negative side, it does not exploit the unique flexibility and easy curving of polycarbonate to achieve interesting structures.

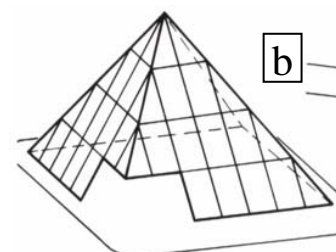
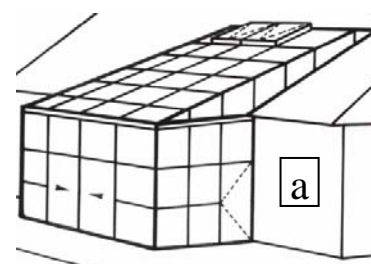
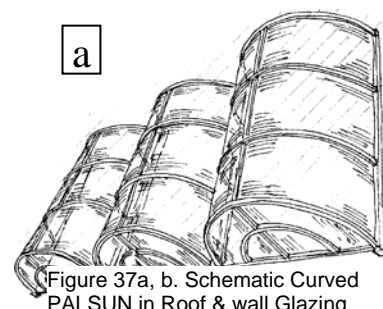


Figure 36a, b. Schematic Flat PALSUN in Roof & wall Glazing

2) Reasons & Arguments for the Use of Curved PALSUN Glazing:

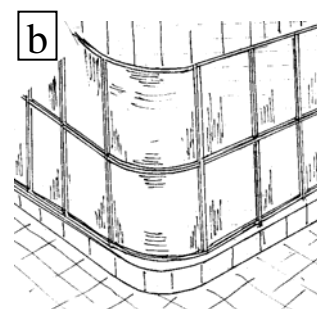
(Cold curved or thermoformed)

- Applied mainly in horizontal installation, (the curve axis is level. fig. 37a.) but possible also in vertical position (curve axis vertical. fig. 37b.)
- Applicable in vaulted roof covers, overhead skylights, canopies & shades, covered walkways, integration with curtain-walls, street & landscape architecture and more. (Fig. 10, 12, 29, 30, 34, 35,37)
- The negative side: most applications above could be done in flat glazing, easier and cheaper.



Working with curved glazing requires more difficult & elaborate detailing. Part of the structural framing elements has to be roll-formed, evenly & accurately, while keeping the internal shape of said elements.

In curving that necessitate thermoforming a drying process should be performed prior to the heat treatment. Both procedures are more time consuming and costly.



General Comments

- All the above should not be considered as a demand or pretext for any obligation of the designer to entrust the project or any part of it to PALRAM or anybody on its behalf, neither as an obligation to purchase the glazing materials from PALRAM.
- The technical assistance and consultation given by PALRAM Tech-Support representative, or anybody on its behalf, in writing or verbally, in print or otherwise, should be considered as a recommendation, given according to professional knowledge and expertise, based on extensive accumulated experience, prior consultation for similar projects and many projects erected along this consultation, given in good faith. PALRAM consultation would not be construed as taking any commitment or obligation to the quality of design or consultation or any other information or detailing given, unless given, in writing, by a special guaranty for a specific project.
- The information and consultation given should not be construed as a recommendation to the suitability of this or that product of PALRAM Ltd. to a specific usage, unless this option for usage has been brought to PALRAM Ltd. attention and approval, in advance and in writing.
- Along with all the above said, application and installation without careful observance of PALRAM recommendations and installation instructions may harm the purchased product and void any and all guaranties.



Inasmuch as Palram Industries has no control over the use to which others may put the material, it does not guarantee that the same results as those described herein will be obtained. Each user of the material should make his own tests to determine the material's suitability for his own particular use. Statements concerning possible or suggested uses of the materials described herein are not to be construed as constituting a license under any Palram Industries patent covering such use or as recommendations for use of such materials in the infringement of any patent. Palram Industries or its distributors cannot be held responsible for any losses incurred through incorrect installation of the material. In accordance with our Company policy of continual product development you are advised to check with your local Palram Industries supplier to ensure that you have obtained the most up to date information.

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