

GLAZING

INTRODUCTION

All of the window breakage problems in schools, institutions, commercial and industrial buildings—homes, too—have necessitated a re-evaluation of glass vs. more breakresistant glazing materials. Aristech Surfaces (safety glazing) cast acrylic sheet is a practical, highly versatile choice. It is durable, lightweight, with a high degree of clarity and at the same time, it offers designers and architects a flexibility that breaks the flat dimension barrier for window surfaces. Curved or formed windows of AcrySTEEL® IGP acrylic sheet can become a complementary part of a building design. This Bulletin is meant to be a quick reference to the benefits and specification details of AcrySTEEL® IGP acrylic sheet. Keep it handy... and if you have additional questions, contact the distributor or Aristech Surfaces, the manufacturer.

A DEFINITION

AcrySTEEL® IGP acrylic sheet is a commercial grade, continuous cast acrylic sheet, derived from a unique formulation. Acrylic is a superior glazing material, thanks to its ease of fabrication and installation; excellent impact resistance; lightweight; unexcelled resistance to weathering; optical clarity; formability and graffiti resistance. It passes ANSI-Z97.1 tests for safety glazing materials for commercial, industrial or residential construction.

ITS DESIGN ADVANTAGES

AcrySTEEL® IGP acrylic sheet offers many advantages to designers, architects, fabricators and glazing contractors that are either not

possible with glass and other materials or economically prohibitive.

SHEETS TO MATCH THE APPLICATION

AcrySTEEL® IGP acrylic sheet is supplied in sheet widths to 110" (280 cm) and in specific thicknesses ranging from 0.080" (2 mm) to 0.500" (13mm). 55" (140 cm) width is of glazing quality. The full 110" (280 cm) width includes a center weld line. Sheet lengths are limited only by the practicality of shipping and handling weights and sizes. However, a wide variety of standard sizes and thicknesses are available in stock for quick delivery. (For listings, including standard colors, color numbers and sizes, see price pages or contact Aristech Surfaces.

BEAUTIFULLY FORMABLE

AcrySTEEL® IGP acrylic sheet can be cold formed at room temperatures to give you generous curved surfaces. Table 1 shows the smallest degree of curvature that can be achieved without imparting excessive stresses within the sheet. Cold forming AcrySTEEL® IGP acrylic sheet beyond the limits listed may result in crazing of the material. However, if unusual shapes or smaller curvatures than those listed in Table 1 are desired, AcrySTEEL® IGP acrylic sheet can be thermoformed. This involves heating the material to approximately 380 °F (195 °C) , then forming the desired shape with vacuum or air pressure. Ask Aristech Surfaces for additional help and information.



TABLE 1

AcrySTEEL® IGP acrylic sheet Thickness	Smallest Permissible Curvature (radius)	Equal to a Circle of
0.080" (2.0 mm)	14.5" (37 cm)	29" (74 cm) dia.
0.125" (3.2 mm)	22.5" (57 cm)	45" (114 cm) dia.
0.187" (4.7 mm)	34" (86 cm)	68" (173 cm) dia.
0.250" (6.3 mm)	45" (114 cm)	90" (228 cm) dia.

MACHINING AND FINISHING

AcrySTEEL® IGP acrylic sheet can be machined readily by observing good machine tool practices. Its characteristics are similar to fine wood, brass and copper. Machine tools such as routers, shapers, drills and saws should be operated at high speeds with slow feed rates. Cold punching and shearing should not be used. Finishing all machined surfaces is easy by hand or machine. Sanding techniques using wet or dry paper of the finest grit are advisable. The surface should be kept wet and all final sanding should be back and forth in one direction only. For complete details on machining and finishing techniques contact your Aristech Surfaces rep. or write us direct.

ITS PERFORMANCE ADVANTAGES

The excellent durability and practical features of AcrySTEEL® IGP acrylic sheet make it a highly beneficial—and cost saving—alternative to glass and other materials for glazing.

LASTING RESISTANCE TO BREAKAGE

AcrySTEEL® IGP acrylic sheet has 10 to 17 times greater breakage (impact) resistance than glass in equivalent thicknesses. And unlike other plastics used in glazing, AcrySTEEL® IGP acrylic sheet has excellent resistance to degradation from weathering and many commonly used household and industrial solvents.

SUBSTANTIALLY LIGHTER WEIGHT

AcrySTEEL® IGP acrylic sheet weighs only about half (46%) as much as ordinary glass.

SAFER TO HANDLE

The resistance to breakage and lighter weight of AcrySTEEL® IGP acrylic sheet makes it a safer material to handle and work with. If breakage should occur, the material does not shatter or splinter. Usually the break is local (a hole) or a clean single break, and the broken edges are dull compared to glass fragments. In fact, code agencies specify acrylics over ordinary glass for storm door and other glazing applications where safety is the main criterion.

VIRTUALLY IMMUNE TO WEATHER

AcrySTEEL® IGP acrylic sheet has outstanding weathering resistance. Even in areas such as Florida and Arizona, acrylics are virtually unaffected after 15 or more years exposure. Acrylics have been used successfully in aircraft glazing since before World War II, and for more than 30 years in outdoor sign applications. See Appendix 1 on page 7 for supporting data.

CLEARER THAN GLASS

AcrySTEEL® IGP acrylic sheet actually has optical properties equal to or better than ordinary glass. Light transmittance for clear AcrySTEEL® IGP acrylic sheet is about 93% as compared to 88% for single-strength glass. See Table 2 below for transmission values for some transparent colors.

TABLE 2 — TRANSMITTANCE OF ACRYSTEEL® IGP ACRYLIC SHEET COLORS

Color	Light Transmittance (%)	Solar Energy Transmittance*
Glass	88	85
Clear	93	90
2074 Gray	12	26
2064 Gray	26	42
2370 Bronze	11	17
2412 Bronze	27	33
2404 Bronze	46	56

* Percentage of total solar energy (BTU) transmitted (NOTE: Consult Aristech Surfaces for information on other colors.)

EFFECT OF ANGLE OF INCIDENCE

The angle of incidence effects the light transmittance of AcrySTEEL® IGP acrylic sheet. Table 3 below illustrates this effect on 0.125" (3.2 mm) thick clear AcrySTEEL® IGP acrylic sheet.

TABLE 3 — EFFECT OF ANGLE OF INCIDENCE ON LIGHT TRANSMITTED (0.125" (3.2 MM) ACRYSTEEL® IGP ACRYLIC SHEET)

Angle of Incidence	Light Reflected (%)	Light Transmittance (%)
90°	7.0	93.0
75°	7.2	92.8
60°	7.6	92.4
45°	8.3	91.7
30°	12.1	89.9
15°	27.9	72.1
0	100.0	0

NOTE: Sun is perpendicular to surface of AcrySTEEL® IGP acrylic sheet at Angle of Incidence of 90°. At 0°, sun is horizontal (same plane) with surface.

SOLAR ENERGY TRANSMITTANCE

AcrySTEEL® IGP acrylic sheet transmits 93% visible light compared to approximately 88% for ordinary float glass. Total average solar energy transmittance is 4 to 6% more for AcrySTEEL® IGP acrylic sheet than for ordinary float glass. This can increase the efficiency of solar collector panels substantially. (See Figures 6 & 7) for AcrySTEEL® IGP acrylic sheet Transmittance Curve and Relative Distribution of Solar Energy, page 6.)

SOLAR ENERGY RERADIATION

AcrySTEEL® IGP acrylic sheet does not allow reradiation of the heat trapped by the black body back to the atmosphere. It transmits only a small amount (less than 5%) at 2.7 microns and none from 2.7 microns to 25 microns.

HIGHLY RESISTANT TO TEMPERATURE EXTREMES

The continuous-use temperature for AcrySTEEL® IGP acrylic sheet is up to 180 °F (82 °C). Higher temperatures can be tolerated for short periods of time without permanent damage. At extremely low temperatures (-30°F (-34 °C)), AcrySTEEL® IGP acrylic sheet remains very serviceable with only a slight reduction in breakage resistance occurring.

HELPS SAVE HEATING/COOLING ENERGY

AcrySTEEL® IGP acrylic sheet is a better insulator than glass! In fact, ordinary glass conducts heat more than 4 times faster. Its heat transfer characteristics are similar to those of rubber. The coefficient of the thermal conductivity (K factor) or ability to conduct heat is 1.4 compared to 5 to 6 for ordinary glass. The over-all coefficient of heat transmission (U factor) is 1.04 compared to 1.25 for glass. At these conditions (see Table 4) AcrySTEEL® IGP acrylic sheet is still approximately a 20% better insulator than ordinary glass.

TABLE 4 — INSULATING VALUES OF ACRYSTEEL® IGP ACRYLIC SHEET

AcrySTEEL® IGP acrylic sheet Thickness	U Factor*
0.125" (3.2 mm)	1.04
0.187" (4.7 mm)	1.00
0.250" (6.4 mm)	0.94
0.312" (7.9 mm)	0.92

* U Factor is the amount of heat, expressed in BTU s, which will pass through one ft² (0.1 m²) of window area per hour for each degree Fahrenheit (0.6 degree Celsius) temperature difference between air on the inside and air on the outside (Values shown are based on 70°F (21°C) and zero wind velocity inside; 0°F (-18 °C) and 15 MPH (24 KMH) wind velocity outside.)

GRAFFITI RESISTANT

AcrySTEEL® IGP acrylic sheet can be easily cleaned of any graffiti. It can be washed with a mild, non-abrasive soap or detergent and water. Oil and grease may be removed with aliphatic naphtha (no aromatic content), kerosene, white gasoline or isopropyl alcohol. Do not use solvents such as acetone, benzene, carbon tetrachloride fire extinguisher fluid, dry cleaning fluid and lacquer thinners, as they will attack the acrylic surface.

ACRYSTEEL® IGP ACRYLIC SHEET PROVEN AND ACCEPTED

Building Codes usually regulate types of building materials and methods of construction. Acrylics are widely accepted as glazing materials. Below is a list of building or testing standards which generally apply:

- ASTM D 4802-02 Category A2, Finish 1 and 2, Type UVF.
- Mil-P-2419-1A (Ships), Grade A through G Acrylic lenses for illumination and signal lighting.
- American National Standards Institute Specifications ANSI-Z-97.1—1972 for caliper 0.080" (2mm) through 0.250" (6.3mm), safety glazing for all sizes of commercial, industrial and residential construction.
- ANSI-Z-26.1—1966(F11973) for caliper of 0.125" (3.2mm) Grades A54, 5, 6 Motor Vehicle Safety Glazing.
- U.S. Department of Transportation (DOT) Motor Vehicle Safety Standard No. 205, Aristech Surfaces has been assigned a code number "DOT 193."
- International Code Council Evaluation Services (ICC-ES), Report No. 2576, Section 5202 of the Uniform Building Code.
- New York City Board of Standards and Appeals Code Section C-26-503 (e)—Glazing—Calendar Number 636-71-SM.
- CPSC 16 CFR 1201—Consumer Product Safety Commission Architectural Safety Standard.

Since building codes and regulations vary greatly from area to area, it is advisable to check with local authorities for specific requirements, and then contact Aristech Surfaces for specific information pertaining to conformance.



ACRYSTEEL® IGP ACRYLIC SHEET – THE SIZING STEPS

To size your AcrySTEEL® IGP acrylic sheet window panes, the following information must be known:

1. Window size (length and width).
2. Wind loading in pounds per square foot (kg/m²) the window pane must withstand. See Table 5 below.

TABLE 5

Approximate Wind Velocity (MPH)	Uniform Load (lbs/ft ²)
75 (121 km/hr)	20 (98 kg/m ²)
90 (145 km/hr)	30 (147 kg/m ²)
100 (161 km/hr)	40 (195 kg/m ²)
130 (209 km/hr)	50 (244 kg/m ²)

FOR WINDOW SIZES 24" X 24" (61 X 61 CM) OR SMALLER:

The AcrySTEEL® IGP acrylic sheet pane can be 0.100" to 0.125" (2.5 mm to 3.2 mm), and cut 1/8" (3.2 mm) smaller in both length and width than the window frame opening. the pane can be bedded and face puttied as illustrated in Figures 1 and 2 below.

FOR WINDOW SIZES GREATER THAN 24" X 24" (61 X 61 CM)

Knowing window size and required wind loading, you can determine the following information from the tables and figures on pages 3, 4, and 5.

1. Recommended AcrySTEEL® IGP acrylic sheet thick ness.
2. Exact AcrySTEEL® IGP acrylic sheet size (to allow for thermal contraction and expansion).
3. Recommended window frame channel or rabbet depth and width.
4. Recommended dimensions for spacing tapes and caulking (weather seal) compounds.

AN EXAMPLE:

If the window (sash) opening is 48" x 96" (122 x 244 cm) and a 30 pound per square foot (147 kg/m²) wind loading is specified:

1. Determine the AcrySTEEL® IGP acrylic sheet thick ness from Figure 3 on page 4. This would be 1/4" (6.4 mm).
2. Determine the Thermal Expansion of the pane from Figure 4 on page 4. These numbers are 1/4" (6.4 mm) for the 48" (122 cm) width and 7/16" (11.1 cm) for the 96" (244 cm) length. Therefore, pane sizes would be 47-3/4" x 95-9/16" x 1/4" (121.3 cm x 242.7 cm x 6.4 mm) thick.
3. From Table 6 on page 5, you would find channel (rab bet) dimensions, spacing tape dimensions, and weather seal dimensions. These are:
Channel Width - 3/4" (19 mm)
Channel Depth - 1-3/16" (30.2 mm)
Tape Width - 13/16" (20.6 mm)
Tape Thickness - 1/4" (6.4 mm)
Seal Width - 1/4" (6.4 mm)
Seal Depth - 3/8" (9.5 mm)

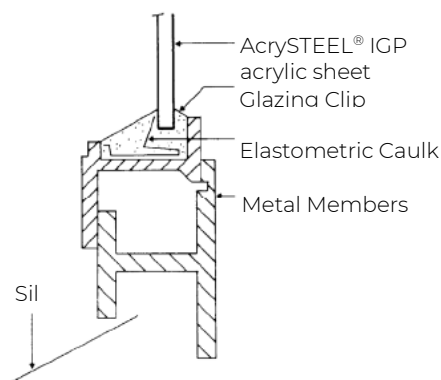


FIGURE 1 - Bedded Joint (METAL)

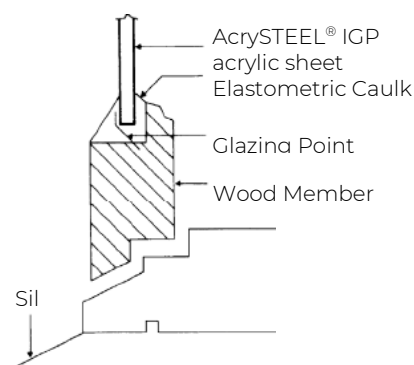
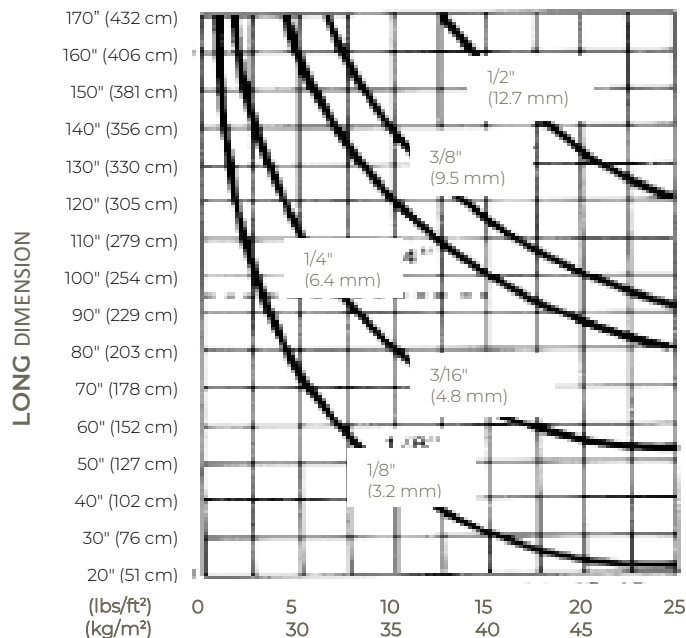


FIGURE 2 — Bedded Joint (WOOD)

FIGURE 3

Recommended AcrySTEEL® IGP acrylic sheet thicknesses. (A in Figure 5)



UNIFORM LOAD

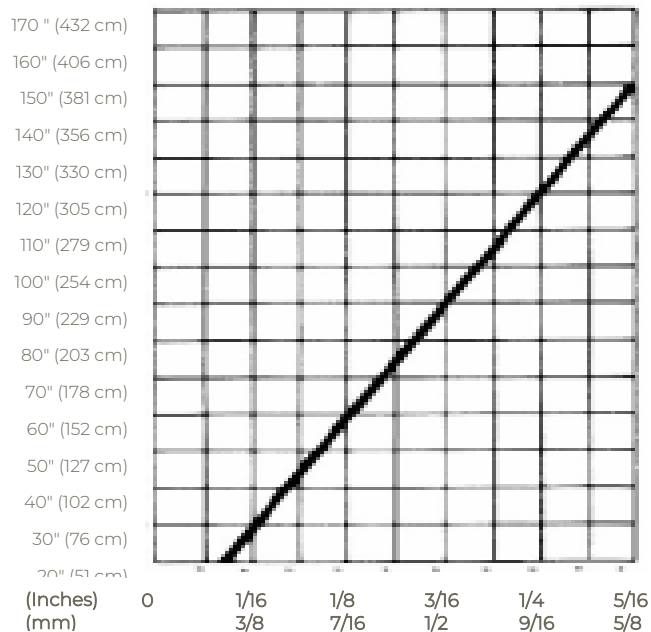
This graph indicates the recommended pane thicknesses according to your Uni- form Load as determined from Table 5.

TABLE 5

Dimension	Letter Code
AcrySTEEL® IGP acrylic sheet Thickness	A
Channel Width	B
Channel Depth	C
Spacing Tape Width	D
Spacing Tape Thickness	E
Weather Seal Depth	F
Thermal Expansion Clearance	G
AcrySTEEL® IGP acrylic sheet Length or Width	H
Window Frame Opening	J

FIGURE 4

Recommended AcrySTEEL® IGP acrylic sheet thicknesses. (A in Figure 5)



THERMAL EXPANSION

Determine the thermal expansion clearances needed for each dimension of the AcrySTEEL® IGP acrylic sheet with this graph.

FIGURE 5

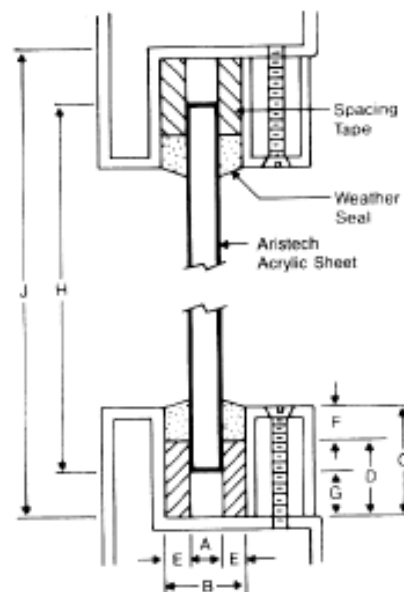


TABLE 6

Design Recommendations													
Long Dimension	Recommended Pane Thick.		Channel (Rabbit) Dimensions				Spacing Tape Dimensions				Weather Seal Dimensions		
			Width		Depth		Width		Thickness		Width		Depth
	A		B		C		D		E		E		F
	(in.)	(mm)	(in.)	(mm)	(in.)	(mm)	(in.)	(mm)	(in.)	(mm)	(in.)	(mm)	(in.) (mm)
20 PSF (98 kg/m ²) Uniform Load													
Up to 24" (61 cm)	1/8	3.2	3/8	9.5	1/2	12.7	—	—	—	—	—	—	—
24 to 45" (61 to 114 cm)	1/8	3.2	5/8	15.9	3/4	19.1	1/2	12.7	1/4	6.4	1/4	6.4	1/4 6.4
45 to 80" (114 to 203 cm)	3/16	4.8	11/16	17.5	1	25.4	5/8	15.9	1/4	6.4	1/4	6.4	3/8 9.5
80 to 120" (203 to 305 cm)	1/4	6.4	3/4	19.1	1-5/16	33.3	15/16	23.8	1/4	6.4	1/4	6.4	3/8 9.5
120 to 144" (305 to 366 cm)	3/8	9.5	1-1/8	28.6	1-1/2	38.1	1	25.4	3/8	9.5	3/8	9.5	1/2 12.7
30 PSF (147 kg/m ²) Uniform Load													
Up to 24" (61 cm)	1/8	3.2	3/8	9.5	1/2	12.7	—	—	—	—	—	—	—
24 to 30" (61 to 76 cm)	1/8	3.2	3/8	9.5	1/2	12.7	1/4	6.4	1/4	6.4	1/4	6.4	1/4 6.4
30 to 65" (76 to 165 cm)	3/16	4.8	11/16	17.5	15/16	23.8	11/16	17.5	1/4	6.4	1/4	6.4	1/4 6.4
65 to 100" (165 to 254 cm)	1/4	6.4	3/4	19.1	1-3/16	30.2	13/16	20.6	1/4	6.4	1/4	6.4	3/8 9.5
100 to 116" (254 to 295 cm)	3/8	9.5	7/8	22.2	1-5/16	33.3	15/16	23.8	1/4	6.4	1/4	6.4	3/8 9.5
116 to 144" (295 to 366 cm)	1/2	12.7	1-1/4	31.8	1-1/2	38.1	1	25.4	3/8	9.5	3/8	9.5	1/2 12.7
40 PSF (195 kg/m ²) Uniform Load													
24 to 57" (61 to 145 cm)	3/16	4.8	11/16	17.5	7/8	22.2	5/8	15.9	1/4	6.4	1/4	6.4	1/4 6.4
57 to 88" (145 to 224 cm)	1/4	6.4	3/4	19.1	1-1/16	27.0	11/16	17.5	1/4	6.4	1/4	6.4	3/8 9.5
88 to 103" (224 to 262 cm)	3/8	9.5	7/8	22.2	1-3/16	30.2	13/16	20.6	1/4	6.4	1/4	6.4	3/8 9.5
103 to 133" (262 to 338 cm)	1/2	12.7	1-1/8	28.6	1-7/16	36.5	15/16	23.8	3/8	9.5	3/8	9.5	1/2 12.7
133 to 144" (338 to 366 cm)	5/8	15.9	1-3/8	34.9	1-1/2	38.1	1	25.4	3/8	9.5	3/8	9.5	1/2 12.7

This table will give you all necessary installation measurements

ACRYSTEEL® IGP ACRYLIC SHEET – INSTALLATION STEPS

AcrySTEEL® IGP acrylic sheet lights, sash, sealants and glazing compounds should be prepared in accordance with good glazing practice and with the following recommendations:

1. Peel back polyfilm masking from edge before installing, immediately after cutting-to-size.
2. The edges of the lights should be thoroughly cleaned with VM&P naphtha before setting in sash.
3. Protect Aristech Surfaces acrylic from excess sealant smears with a paperback adhesive tape around the edges adjacent to the rabbets.
4. Aristech Surfaces acrylic glazing should be regarded as a finishing operation and should be scheduled as one of the last steps in the completion of the building. If this is not practical, the Aristech Surfaces acrylic is protected from paint, plaster and tar splashes with the polyfilm masking.

The polyfilm masking should be removed as the last step in the finishing process.

SASH

1. Sash surfaces should be thoroughly cleaned and the sealant manufacturers recommended primer applied to assure proper adhesion to the sealant.
2. Remove all projections in the sash rabbet.

SEALANTS

1. Sealants should have the manufacturer's recommended proportions of additives, and should be applied in accordance with manufacturer's recommendations.
2. Mixed sealants should be used as quickly as possible after mixing, rather than during the latter part of their pot life.



CEMENTING

Strong, transparent joints can be obtained in cementing sections of AcrySTEEL® IGP acrylic sheet together by paying careful attention to preparation of the mating surfaces, proper choice of cement, and following the correct cementing technique. Preparation of surfaces requires cleaning and fitting with uniform contact over the complete area of the joint. Surfaces to be joined should be smooth but not polished prior to bonding. Recommended cements generally are two-component types: a mixture of methyl methacrylate monomer and methyl methacrylate polymer, plus a catalyst. However, satisfactory bonds can be achieved using one-component solvent cements. Cementing is a simple procedure when the proper environment and precautions are used. For complete details on cementing, talk to your Aristech Surfaces representative or write us direct.

REMOVAL OF GLAZING COMPOUND

Glazing compound can be removed from AcrySTEEL® IGP acrylic sheet by using a soft cloth wet with VM&P naph-tha, kerosene or white (unleaded) gasoline, followed immediately with soap and water. Never use razor blades or other sharp instruments, such as a putty knife, to remove spots.

Figure 8—Relative Distribution of Solar Energy

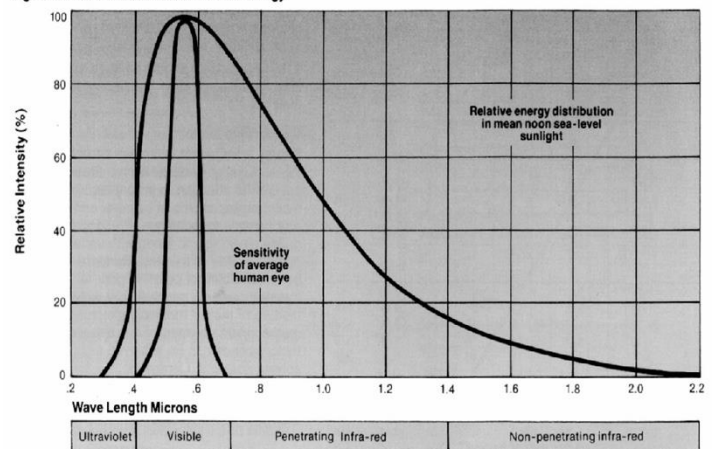
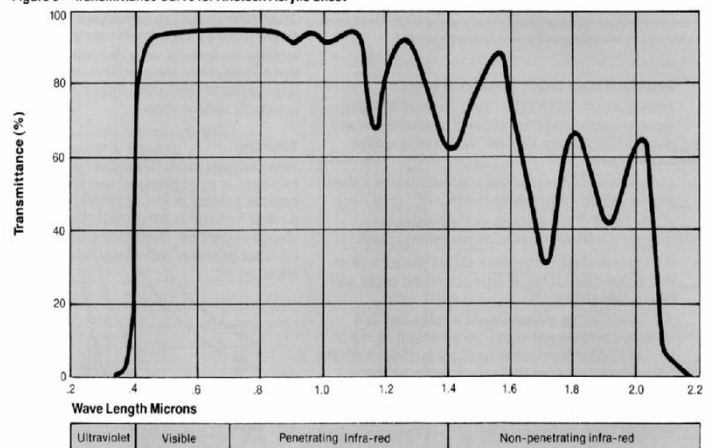


Figure 9—Transmittance Curve for Aristech Acrylic Sheet



CLEANING

When AcrySTEEL® IGP acrylic sheet becomes dirty, wash with mild soap or liquid detergent and water. Use as much water as possible in washing. Apply to large areas with a bristle mop and to small areas with a clean soft cloth, sponge or chamois. Do not use window sprays, cleaning fluids or alcohol, which may have a damaging effect.

APPENDIX I—SAND 74-0241 —Unlimited Release—Printed September 1974 EFFECT OF OUTDOOR AGING ON ACRYLIC SHEET L. G. Rainhart, Process Laboratory Division 3622 W. P. Schimmel, Jr., Heat Transfer and Fluid Mechanics Division 1543 Sandia Laboratories, Albuquerque, New Mexico 87115

Presented at the 1974 International Solar Energy Society, U.S. Section Annual Meeting, held at Colorado State University, Ft. Collins, Colorado, August 20-23, 1974.

ABSTRACT

One of the prime contenders for solar reflectors or concentrators is acrylic plastic. Other than the basic requirement of being a highly efficient reflector or transmitter of the solar spectrum, it must offer excellent long-term weatherability with minimum cost. The weatherability of acrylic polymers, although known to be good compared to other polymers, has been an unknown with regard to actual exposure data in the southwestern United States where the potential is high for solar energy installations. This report is a

compilation of data obtained from an acrylic panel that has been exposed for over 17 years in the semi-arid desert terrain south of Albuquerque, New Mexico. A comparison is made with unexposed material having a very similar polymer structure. In general, chemical changes are not detectable while mechanical response shows some evidence of embrittlement. In spite of these, the decrease in optical transmission is surprisingly low. The as-recovered material (with dust eroded surface) had an integrated or total transmittance which was 10% less than the control material, based on a solar radiation spectrum. In order to isolate the degradation loss due to change in the basic polymer, a polished specimen of aged material was tested and showed only a three percent drop in transmission across the solar spectrum. It appears reasonable that this low loss could be duplicated in a solar reflector.

THE MATERIAL

AGED PANEL

On January 19, 1956 a 4" x 12" x 1/8" (10.2 cm x 30.5 cm x 3.2 mm) piece of cast acrylic-cross linked, was mounted in the static test frame at Sandia Laboratories exposure site. This semi-arid location is some five miles southeast of Albuquerque on a sandy plain elevation—(5200'). The panels as mounted on the exposure racks, face due south at 45° to the horizontal. The weathered panel was removed from the rack on September 24, 1973 for an elapsed exposure time of 17 years and 8 months.



Note: for cautions and information on exposure to any Aristech Surfaces' product, please see the applicable material safety data sheet.

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