Technical Information

ACRYLITE® extruded (FF)

#2 Signs

This brief gives advice for:

- Planning and Design
- Fabrication in Sign-Making Making the Sign
- Decorating the Sign Face
- Mounting the Sign (In-shop, On-site) Cleaning
- Equipment and Materials Suppliers
- Additional Technical Information and Assistance

Planning And Design

This section gives advice for:

- Applications
- Service Temperature
- Expansion and Contraction Allowances
- Weather Resistance
- Code Information
- Safety
- Material Strength and Stresses
- Mold Design/Materials
- Luminance
- Designing the Sign Boxes
- Planning for Service

Applications

You can use ACRYLITE® extruded acrylic sheet in the manufacture of the following interior and exterior signs:

Display Signs: Point of purchase displays, including silk-screened or painted designs.

Illuminated Signs: Fabricated and/or deco-rated panel signs (flat, raised, or thermoformed) illuminated from behind using fluorescent lamps or tubes.

Painted Signs: Sign face may be hand-painted, spray-painted, or silk-screened by standard systems.

Raised-Letter Signs: Flat letters of ACRYLITE® extruded sheet cut by mechanical means or by laser and then cemented into place of held to background sheet using fasteners.

Single Illuminated Letters or Characters (Shapes): Raised thermoformed sign letters fastened to a flat panel or used individually.

Thermoformed Signs: Small 2"x2" or less, or large signs thermoformed in vertical or horizontal ovens.

Service Temperatures

Use ACRYLITE® extruded sheet at temperatures from 30°F (-34°C) to +190°F (88°C), depending on the application. Temperature should not exceed 160°F (71°C) for continuous service or 180°F (82°C) for short, intermittent use. Do not expose components made of ACRYLITE® extruded acrylic sheet to high heat sources, such as high wattage incandescent lamps, unless you ventilate the finished product enough to dissipate heat.

Expansion and Contraction Allowances

Allow for expansion and contraction of the sign face. The coefficient of linear expansion is

0.000040 in/in -°F (0.000072 in/in -°C). A temperature change of 100°F (56°C) will cause ACRYLITE® extruded sheet to change dimensions by about 3/64" (1.2 mm) per foot. The following table is adequate for installation at room temperature (68°F or 20°C) with a maximum face temperature of 160°F (71°C) and a minimum face temperature of -30°F (-34°C).

Expansion and Contraction allowances (due to temperature changes)

Sign Dimension at Room Temperature 68°F (20°C)	Expansion for Temperature 160°F (71°C)	ContractionTemperature -30°F (-34C)
Feet	**Inches**	**Inches**
2	3/32	3/32
3	1/8	9/64
4	11/64	3/16
5	7/32	15/64
6	17/64	9/32
7	5/16	21/64
8	23/64	3/8
9	25/64	27/64
10	7/16	15/32

Examples:

- For a sign face of four by eight feet, allow expansion of 11/64" and contraction of 3/16" for the four foot length. For the eight foot length, allow expansion of 23/64" and contraction of 3/8 ".
- For lengths not in even feet, go to the next larger dimension in the table. Thus, tor a length of 6'5", use the seven foot dimension.
- For lengths larger than ten feet, simply combine dimensions found in the table to determine expansion and contraction allowances. For a length of 17 feet, combine the ten and seven foot dimension allowances (expansion = 7/16" + 5/16 "; contraction= 15/32" + 21/64 ").

Weather Resistance

ACRYLITE® extruded sheet will withstand intense sun, extreme cold or heat, sudden temperature changes, salt water spray, and other weathering/ temperature factors. Acrylic is inherently stable and will not deteriorate after many years of service. Colorless ACRYLITE® extruded sheet is warranteed for 30 years against loss of light transmission. Other plastic sign materials are more prone to deterioration. ACRYLITE® extruded sheet has been accepted for signs, schools, industrial plants, and interior insulating windows.

Code Information

Design ACRYLITE® extruded signs to meet requirements of Underwriters Laboratories standards for Safety Electric Signs-UL48 (in the U.S.) and C22-2 no. 2 (in Canada) as well as applicable municipal sign ordinances. Regulations vary, so check local codes.

Safety

ACRYLITE® extruded is safer than glass because of its greater breakage resistance. When subjected to an impact beyond its resistance limit, it does not shatter into small slivers but breaks into comparatively large pieces. A ACRYLITE® extruded complies with American National Standards Institute {ANSI) 297.1-1975, Safety Glazing tor Buildings and Canadian Government Specifications Board (C.G.S.B.) CAN-2-12-12, 1979, Glazing Sheets, Plastic, Safety.

Material Strength and Stresses

Although ACRYLITE® extruded tensile strength is 10,000 psi at room temperature (as measured per ASTM D 638), continuous loads below this value can cause stress-crazing. In applications subject to continuous loading, design loads should not exceed 750 psi at 73°F. (23°C).

Mold Design/Materials

Adjustable-size mold bases are commercially available-for example, the PVI (Plasti-Vac, Inc.) aluminum extrusion system, which features a porous mold board, can be obtained on the commercial market.

Molds can be of wood for short runs; aluminum is best for long runs. An S.P.E. #5 mold finish will prevent air entrapment if your tool is metal. Cover a wooden tool with felt, rubberized flocking, or thin polyurethane foam. To achieve special background effects, use woodshake shingles, expanded metal, bamboo curtains, or other similar materials.

Luminance

Thickness tolerance for ACRYLITE® extruded is carefully controlled, enhancing the sign's consistent color transmission. Dark lettering on a large, bright background attracts more attention than bright lettering on a dark background if the sign is not back-lit. For back-lit signs, the reverse is true. If the width of the letters is about 1/7 the height of the letters, they can be read from a maximum distance of about 600 times the height of the lettering.

Adequate luminance of the bright sign background is necessary in back-lit signs. If luminance values chosen are too low, the sign may be too dark and lack eye appeal. Excess luminance may cause glare, reducing the sign's effectiveness.

Designing the Sign Box

In sign box design, provide sufficient support for the face. Minimize face bending or twisting, since either could cause blowout or damage. Sign box design should provide tor easy servicing.

Planning for Service

Plan easy servicing access. For small signs, provide a hinged end panel to slide the face out of the frame. For larger signs, hinge one side or install service doors in the frame.

Fabrication In Sign-Making

This section gives advice for:

- Marking
- General Fabrication
- Cutting
- Drilling
- Routing
- Edge and Surface Finishing
- Cementing
- Thermoforming

IMPORTANT: The handling and fabrication information in this section is intended as a guide. More detailed information for equipment, procedures, trouble-shooting, and equipment materials suppliers is provided in the Fabrication Tech Briefs.

Copies of these briefs are available from authorized ACRYLITE® sheet distributors. See the ADDITIONAL TECHNICAL INFORMATION AND ASSISTANCE section at the end of this brief for details.

Marking

You can mark paper masking with most writing tools, including pencils or ball point and felt tip pens. On polyethylene masking, mark with grease pencils and certain felt tip markers. See Fabrication Tech Brief #1, Handling/Maintenance, for equipment and materials suppliers as well as general information.

General Fabrication

Woodworking equipment is usually adaptable for use with ACRYLITE® extruded acrylic sheet. Note, however, that exceptions exist. Improper fabrication techniques or dull tools may cause slight melting of ACRYLITE® extruded sheet. Watch for this during cutting or trimming operations. Proper tools and methods are available tor an excellent edge finish. A router is satisfactory. Band saw cutting may require further edge finishing, depending on the quality of the cut.

For more information, refer to Fabrication Tech Briefs #2 and #5, Cutting with Circular Saws and Routing.

Many plastics, including acrylics, are notch sensitive and can crack if edges are smoothed insufficiently. A smooth edge increases sheet strength. After cutting, smooth the edges to

remove uneven ridges. Use a router, scraper, or carbide double-edged scraping tool. Edge surface also affects chemical compatibility. After trimming, but before painting, mask the edges. This prevents solvent attack and pads the edges to protect against wind vibration after installation.

Cutting

A table saw is best for cutting ACRYLITE® extruded sheet. Other methods of cutting include travelling panel saws and band saws. Control vibration to prevent overheating. Cutting speed should be fast. How much finishing is needed to produce a smooth, notch-tree edge is in direct proportion to the quality of the saw cut. Select a carbide-tipped blade for a durable cutting edge. A sharp blade will reduce finishing work. The blade's teeth should be of triple-chip design, with a beveled cutting edge on every other tooth to help clear saw chips. Prevent heat build-up with a spray coolant, thus reducing finishing effort.

If you plan to cut ACRYLITE® extruded sheet into individual letters, decals, logos, etc., laser cutting offers an attractive option. A C02 laser focuses energy onto a small, defined area, melting and vaporizing the sheet. This yields a clean, polished, chipfree edge. Use lasers to cut complex parts with minimal waste. However, since a laser imparts a high level of stress to the sheet's edge, anneal the part if you plan to apply solvent cements, paints, or inks to the edge.

For more information, refer to Fabrication Tech Briefs #2, Cutting with Circular Saws, #3, Other Methods of Cutting, #8, Cementing and #12, Annealing.

Drilling

Drill bits designed for acrylic sheet are available from ACRYLITE® sheet distributors. These bits are designed for a clean, sharp hole. Bits made for use with metal can overheat acrylic and create stresses, cracking the sheet. However, such bits can be modified for use with acrylics.

When drilling, solidly clamp the workpiece to the table. Back up the piece with acrylic or plywood so the bit will continue on into solid material after it penetrates the bottom surface. Use a slow feed at first to allow the bit to enter the material. Again, slow the feed rate at the bottom of the hole. Using a counte'rbore, deburr any hole which may be subjected to forces from screws or bolts. Use a drill of larger diameter than the hole and deburr the rough edge on the exit side of the hole.

For further information, refer to Fabrication Tech Brief #4, Drilling.

Routing

If finishing is required, rout the edges of individual letters for smooth ness. The router can be hand-held or mounted upwards through a table. Select a double-fluted, carbide-tipped bit with a large-diameter shank long enough so that the entire collet chucking length is used. Keep cutters sharp. Dull bits cause chipping and overheating. Routers should have a no-load speed of 18,000 to 20,000 rpm.

Use a hand router and work with a precut template pattern to produce prototype and replacement parts. The template may be made of plywood, fiberboard, or similar material. Guide the router around the pattern using the sub-base, template guide, or router bit pilot bearing assembly as the guide.

For further information, refer to Fabrication Tech Brief #5, Routing.

Edge and Surface Finishing

You can finish the edges of ACRYLITE® extruded acrylic sheet by any of several methods, depending on the finish desired:

Polishing-restoration to high luster

Sanding-matte or satin finish

Scraping-matte finish

Flame polishing–high luster (subject to edge stresses)

For further information, refer to Fabrication Tech Brief #6, Edge and Surface Finishing.

Cementing

Cement ACRYLITE® extruded acrylic sheet using common solvent cements or polymerizable cements. Machine the part's edge sufficiently to avoid stresses. Cement and cement fumes should not contact formed or polished surfaces.

Be sure to obtain a Material Safety Data Sheet (MSDS) from the manufacturer of the cement you choose, and follow their recommendations regarding ventilation and personnel safety.

For further information, refer to Fabrication Tech Brief #8, Cementing.

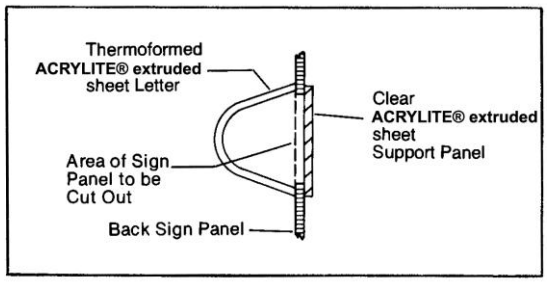
Cementing Flat Letters (Characters/Logos)
Capillary cementing is well suited for attaching flat letters to a sign panel.

CAUTION: Improper cutting, drilling, and routing techniques can cause stresses. This can lead to stress crazing. It is helpful to anneal the material.

You can apply unannealed letters or characters with embodied solvent cement placed in the center of the part. Seal the perimeter from dust and water using silicone.

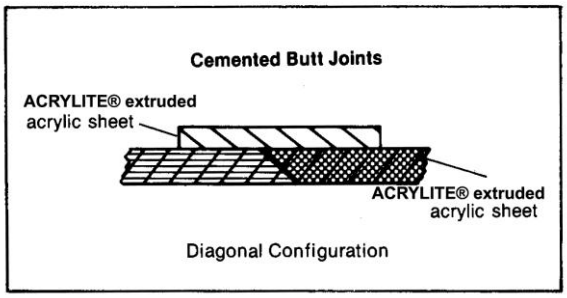
Cementing Raised Thermoformed Letters (Characters/Logos)

Fasten raised injection molded or thermoformed letters or characters to a flat panel by running a bead of solvent cement around the edge of the figure. If the panel is a color, but not white, you can improve the sign's light transmission by cutting out the area of the panel directly behind the figure, allowing a 1/16"-wide lip. This assures sufficient room for a strong bond. Cement a clear piece of ACRYLITE® extruded sheet of similar thickness to the back of the sign panel to increase its strength.



Multipanel Signs

You can join adjacent panels to extend a sign's length as long as the joint is sufficiently strong. Avoid flat butt-jointing two adjacent panels. You'll create a stronger joint when you machine adjoining pieces in a diagonal pattern. Machine the diagonal configuration by adjusting the saw blade to a 45° angle. Cement the joint for strength. It's a good idea to cement a clear back-up plate directly to the joint.



Thermoforming

Evonik CYRO has engineered ACRYLITE® extruded acrylic sheet for excellent forming capability. It has deep draw characteristics, unlike ACRYLITE® cast (GP) or other similar materials. Thus, molds for ACRYLITE® extruded sheet must be designed exactly to the configurations desired.

ACRYLITE® extruded sheet softens as the temperature increases above 170°F (77°C). This gradually changes it from the thermo-elastic state to the thermo-plastic state.

Forming temperatures range between 290°F (140°C) and 320°F (160°C) ACRYLITE® extruded sheet has little "memory" after forming. If reheated, it probably won't return to its original flat shape.

For further information, refer to Fabrication Tech Brief #1 0, Thermoforming.

Making The Sign

This section gives advice for:

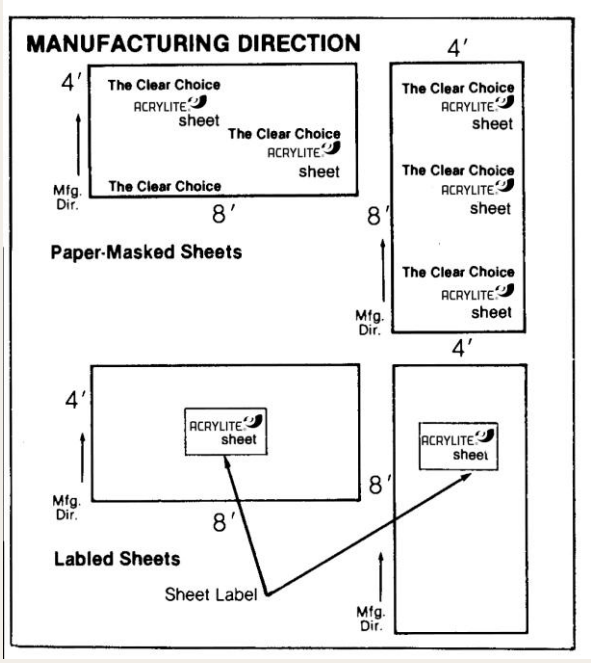
- Working with Molds
- Shrinkage
- Draft of Tooling
- Raised Letter Design Tool
- Mu1tiple Letters from a Single Sheet
- Panel Sign Face Tool
  Thermoformed Sign Tool
- Strong Edge Design

Working with Molds

For short runs, the fastest way to make signs is by using a universal panel mold base. This system's board does not require vacuum holes. Fasten interchangeable letter molds or forms to the base board as required.

Shrinkage

Because sheet shrinks during heating and forming, use a tight clamping frame. Shrinkage is in the direction of manufacture. Manufacturing direction must be determined while there is still a label or masking on the sheet. If there's a label, manufacturing direction is bottom to top as you read it. If you're looking at masking, manufacturing direction is bottom to top as you read the printed lettering.

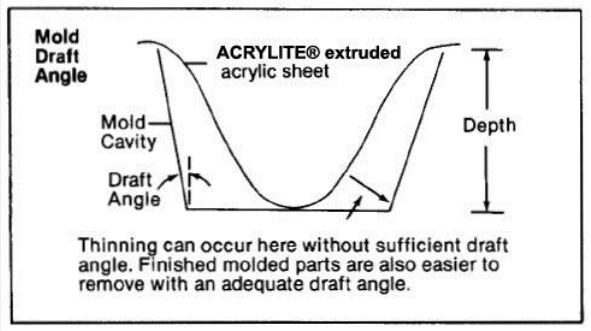


Maximum shrinkage of ACRYLITE® sheet is3% for thicknesses of 0.118" and above. Shrinkage may be greater for thinner gauge sheet Don't confuse shrinkage with thermal expansion/ contraction, which is the normal repeating behavior of acrylic sheet

Draft of Tooling

Depth of Projection		Draft Angle
inches	mm	
1/4-1/2	6 to12	5º
1/2-3/4	12 to 19	7 ½º
3/4- 1 ¼	19 to 32	10º
1 ¼- 1 ½	32 to 38	15º
1 ½-3	38-76	20º

To avoid excess thinning of ACRYLITE® extruded Sheet we suggest the following mold draft angles

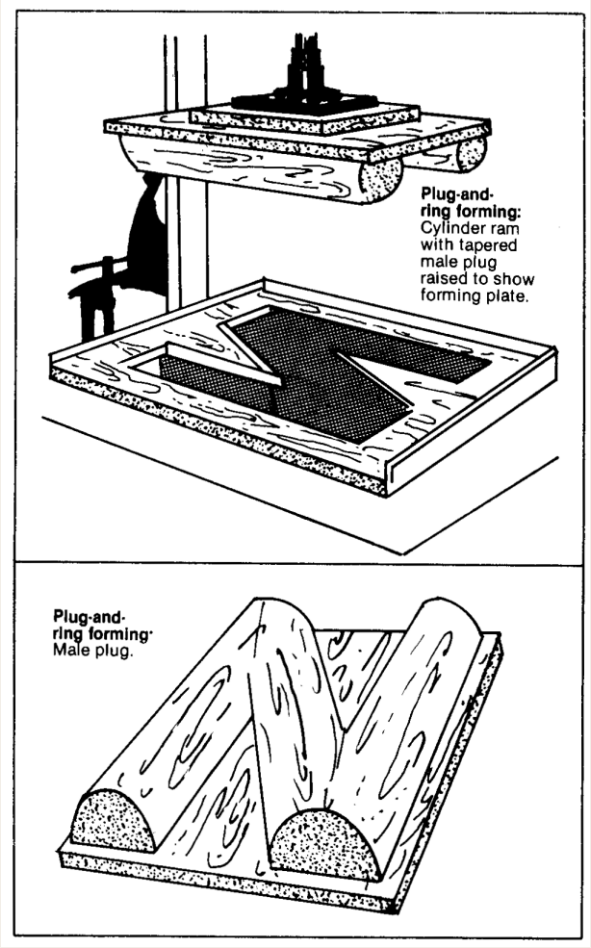


Raised Letter Design Tool

Most sign-makers form single letters by the plug-and-ring method. Use this method for sign components that are not drawn deeply and when mark-oft (impression left by the tool} at the inside corners is acceptable. The mold consists of a forming plate, a clamping plate, and a male plug

A molded part's outside contour conforms to the forming plate's opening. The clamping plate is similar to the forming plate, but its opening is somewhat larger. The slightly tapered male plug is smaller than the forming plate's inside dimension. This is because there must be clearance equal to the thickness of the ACRYLITE® sheet between the male and female parts of the mold. Normally, molds are set up in an air cylinder press. However, you can form smaller parts in an arbor press or on a drill press. Place the heated sheet on the forming plate and hold it down with a clamping plate. Use toggle clamps or C-clamps to hold the three pieces together under pressure.

Force the male plug, which may be a letter or other shape, through both rings to a predetermined depth. You can make the rings (plates) from hardboard, plywood, or metal. It's usual to make the plug of hardwood; it can be covered with a flocked rubber sheet to control "mark-off". Use aluminum castings for large production runs.



Edges of formed letters are normally somewhat flared out, and thus not flat enough to produce a good bond. Sand them flat prior to cementing.

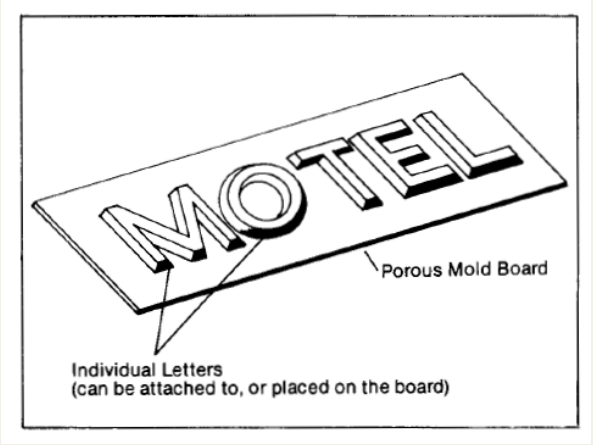
Multiple Letters from a Single Sheet

Allow enough space between letters, a minimum of ½ times the depth of the letter, using the proper draft angle. Round sharp mold edges to prevent overstresses. Avoid excessive depth.

Keep the draw down ratio low, 3:1 or less. This means the sheet should not be stretched more than three times its original size. Experience shows that drawing down to a one-inch depth with a 3-inch gap between letters or other dimensions in the same proportion makes the most durable sign. Width of the letters is not a factor in this computation.

Panel Sign Face Tool

It's usual to thermoform raised panel sign faces on a universal mold base. Several sign supply houses will sell you raised thermoformed panels. Or, produce them in-house if you have thermo-forming capability.



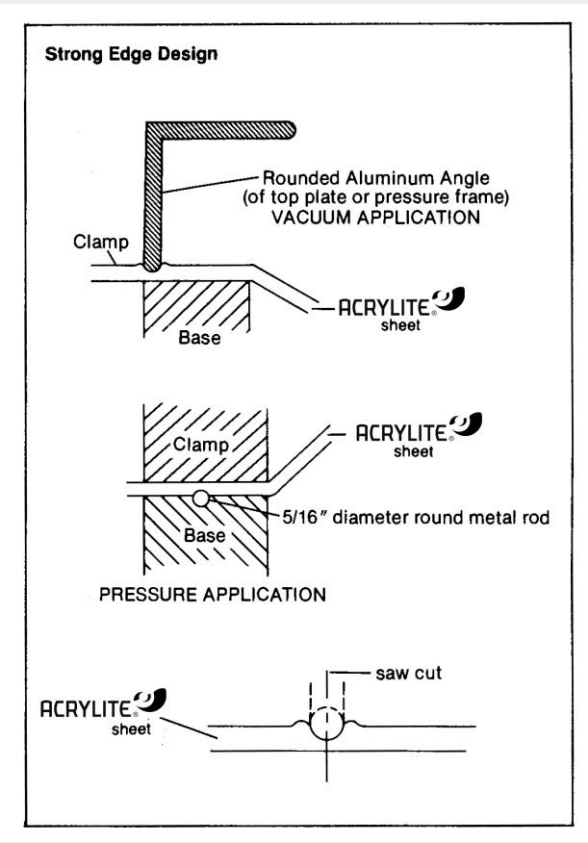
Thermoformed Sign Tool

Produce thermoformed sign faces using either a male or female mold. Male molds are most common. Fasten precut letters or designs to the universal mold base using brads. An advantage of the female tool is easier release of the molded part resulting from material shrinkage away from the mold during cooling.

Strong Edge Design

Because of acrylic sheet edge's notch sensitivity, incorporate a so-called "strong edge design" into your tool. Strong edges (200-300% improvement) can be achieved by designing a bead configuration within the tool to give the edge significantly higher impact strength. This method works for material 2.5 mm (0.100 inch) thick or greater.

Improvement is made by the impression of a 5/16" round rod or angle iron pressed into the heated plastic to a depth of 3/32 ". Place the saw trim cut directly in the middle of the depression, as shown in the lower drawing at right.



Decorating The Sign Face

This section gives advice for:

- Painting
- Pigment Selection

You can hand-paint, stencil cut (using paper or spray masking), or silk-screen signs of ACRYLITE® extruded acrylic sheet. In each case, prepare the surface. See the description of cleaning procedures under "Maintenance" at the end of this brief.

It's best to protect the outside edge by masking it before painting. If you don't mask, stop the paint at least 1/4" from the edge. Signs can be painted before thermoforming-use shading during the heating cycle.

If the paint manufacturer's recommended cleaner is compatible with acrylic sheet, use it to remove excess paint and mistakes. Do not redo signs made from ACRYLITE® acrylic sheet; i.e., strip the paint and

repaint the sign face. If you redo signs, you may see a ghosting effect from the old paint.

Follow the paint manufacturer's recommendations they're found in the company's sign finishing manual. For further information, refer to Fabrication Tech Brief #9, Painting.

Pigment Selection

In choosing a pigment, be sure to understand the difference between durability and color-fastness. A color may have excellent permanence on its own, but when it's tinted or shaded with white or other colors, permanence may be reduced. Similarly, if you reduce a color with a compatible clear to gain translucency or transparency, you may lose permanence.

Mounting The Sign (In-shop, On-site)

This section gives advice for:

- Mounting Considerations
- Edge Engagement Allowances
- Hanging and Supports

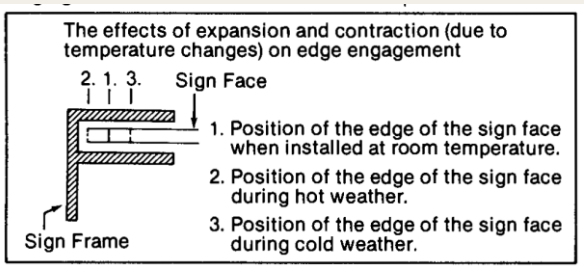
Mounting Considerations

Consider the following when mounting signs:

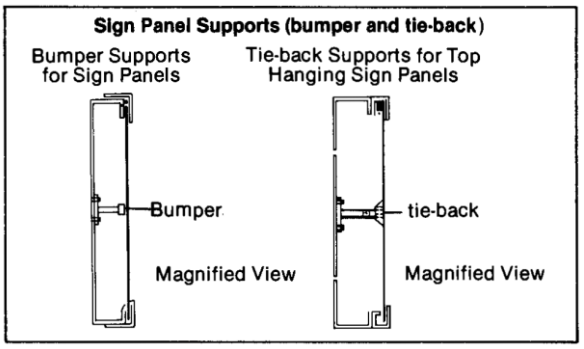
- Thermal expansion and contraction of the sign face. Humidity is adequately covered by the formula for temperature expansion since high humidity normally exists with high temperature. See the section at the beginning of this brief entitled Expansion and Contraction Allowances.
- Foreshortening by deflection under load.
- Panel shifting from end to end.
- Fabricating tolerances (width of saw kerf).

Edge Engagement Allowances

Since ACRYLITE® extruded sheet expands and contracts approximately 3/16" for every four feet in length (for a temperature change of 100°F.), design the sign box to allow for wintertime contraction to avoid blowout. Provide adequate edge engagement under all service temperatures.



Adequate edge engagement is also important to prevent the face from disengaging or dropping out in high winds. See the following section.



Hanging and Supports

Tie-backs, bumpers, and top-hanging are success- fully used to retain sign faces in high winds. There are various designs of tie-backs, Typically, a piece of ACRYLITE® extruded sheet is cemented to the back of the sign face and attached to a metal angle coming from the sign frame. Cement tie-backs to the ACRYLITE® sheet sign face, spacing them uniformly for sufficient stiffness. Plan spacing carefully to prevent shadowing. Tie-backs have an advantage over bumpers since they retain the sign against both negative and positive wind forces.

Bumpers protect against positive wind forces only. They are EPDM or rubber (typically neoprene) buffeting or cushioning devices attached to the sign frame. Bumpers. stop the sheet from deflecting into the sign frame under strong wind loads. Use them for thermoformed signs where stiffening is unnecessary. Firmly affix bumpers to the structural framing. They should extend out to

within one or two inches of the face.

Top-hanging reduces sag and "oil-canning" (expansion of the sign face from the edges to the center and resulting ripples). This is because total face weight is suspended from the top. To construct a top-hanging bar, cement a continuous piece of ACRYLITE® extruded sheet, 6 mm (.236 ") thick by 1/2" wide, along the top edge of the sign face. Then slide the face and bar into the upper hanging bracket from one end.

Cleaning

ACRYLITE® extruded acrylic sheet's smooth surface lends itself to easy cleaning. Clean all signs at least once a year to remove surface build-up from air contamination. More frequent cleaning may be needed in some surroundings-for example, an industrial area. For routine cleaning, use a mild detergent and water solution. Rinse thoroughly and wipe with a lint-free cloth or chamois.

Fire Precautions

ACRYLITE® sheet is a combustible thermoplastic. Precautions should be taken to protect this material from flames and high heat sources. ACRYLITE® sheet usually burns rapidly to completion if not extinguished. The products of combustion, if sufficient air is present, are carbon dioxide and water. However, in many fires sufficient air will not be available and toxic carbon monoxide will be formed, as it will when other common combustible materials are burned. We urge good judgement in the use of this versatile material and recommend that building codes be followed carefully to assure it is used properly.

Compatibility

Like other plastic materials, ACRYLITE® sheet is subject to crazing, cracking or discoloration if brought into contact with incompatible materials. These materials may include cleaners, polishes, adhesives, sealants, gasketing or packaging materials, cutting emulsions, etc. See the Tech Briefs in this series for more information, or contact your ACRYLITE® sheet Distributor for information on a specific product.

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