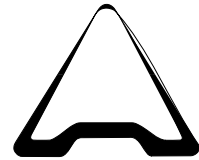


General Aquarium Window Specifications

Revision 1.01
Dated: 9.11.05



ALTERNATIVE PLASTICS

Acrylic Blocks

Monolithic blocks (cast in one piece) are available in sizes up to 8000 x 3000mm and up to a thickness of 250mm are possible. See our size guide for standard cast sizes. Other bonded sizes, curves, tunnels, and bonded structures are available on request.

Aquarium glazing and similar applications are exposed to high mechanical loads over long periods of time so the resulting stress and deflection should be carefully considered when determining the material thickness. Bonding poses particular problems and calculations are made using finite element design software.

To confidently design respecting the material limits we only use very high quality acrylics which are inherently homogeneous with known properties that are ensured by a manufacturing specification and quality testing throughout the process.

Specifications

Special Quality Test

The 'Aquarium Grade' of our ALT Grade Acrylic blocks is subjected to a special quality test. Based on this test, EN 10 204 Certificate of Compliance with the Order "2.1", Test Report "2.2", Inspection Certificate "3.1.B" can be provided in compliance with Lloyd's regulations, as is required for "inhabited" diving aquariums. This special quality meets or exceeds all of the minimum physical values specified in ASME PVHO-1, Table 2-3.1, and the relevant ASTM specifications.

'Aquarium Grade' testing covers all physical properties of importance for material behaviour. It is performed in all three layers of the material for each production batch and therefore enables us to advise our customers on an absolutely reliable set of properties. We are in a position to offer you ALT Grade blocks extensively tested and certified for a wide range of applications which include, pressure chambers, underwater applications, aquarium glazing etc. and offers you maximum safety in use. Alternative Plastics will etch a serial number in to each bonded Aquarium Grade window for identity and matching with the Aquarium Grade certificate detailing tests carried out on a piece of material from the original production batches.

We have the capability to supply acrylic material for windows and Type 1 custom castings according to the requirements of ASME PVHO-1, Section 2, Article 3. SAFETY STANDARD FOR PRESSURE VESSELS FOR HUMAN OCCUPANCY:2-3.5 (a) Type 1 custom castings are defined as being of such thickness and configuration, and produced by such a process as to meet the requirements of Table 2-3.1 without experimental verification.

Commercial grade acrylic complies with ISO 7823-1 "Plastics – Poly(methyl methacrylate) sheets – Types, dimensions and characteristics – Part 1: Cast sheets." Alternative Plastics will use ALT commercial grade or ALT Aquarium Grade acrylic depending on the size or application of the tank or window.

Design Criteria

Material thickness or the maximum allowable pressure is calculated using finite element modelling. Special attention is always given to fatigue, creep and chemically bonded joints. Factors such as service strength, impact resistance, rigidity, thermal expansion, water absorption, edge support and special user requirements can be considered. Detailed calculations by a qualified structural engineer are required to confirm this analysis when the customer deems the tank /window may pose a danger to people, the exhibit, the environment and/or property.

General

Modulus : 3300 Mpa

Poisson's Ratio: 0.37

Monolithic viewing panels

Maximum allowable long-term stress, water side: σ_{permiss} 3Mpa

Maximum allowable long-term stress, air side: σ_{permiss} 5Mpa

Chemically joined (Bonded) acrylic viewing panels

Aquarium Grade - Maximum allowable long-term stress: σ_{permiss} 3Mpa

Deflection criteria

Acrylic viewing panels shall have a maximum initial deflection based on the following:

4 Sides Support: 1/300 of the shorter opening dimension

3 Sided Support: 1/400 of the shorter opening dimension (or supported at the top and bottom only)

Bonded tanks/panels: 1/500 of the longer opening dimension or 1/400 of the shorter opening dimension whichever is less.

The above design criterion meets or exceeds the allowable safety factors stated in the latest revision of ASME PVHO-1 standards for aquarium grade monolithic blocks.

DIMENSIONS (at 20-26 °C)

All viewing panel edges will be chamfered at a 45° angle at a width of approximately 0.4x the thickness (minimum 3mm – approx 6mm maximum) to help avoid damage to these edges during shipping and installation and suit the installation criteria. The panel/tanks dimensional tolerance shall meet the criteria below in order to meet the design criteria and to minimise installation difficulties.

Flat Panels

Thickness : +10% to -5%

Length, width & height: +-0.16%

Panel flatness: 0.35% of the panel length when measured from corner-to-corner of the un-restrained panel, laying on a flat surface.

Warp and twist: 0.5% of the length when measured three corners relative to the fourth of the unrestrained panel, laying on a flat supporting surface.

Curved panels & tunnel sections

Thickness: +10% to -5%

Cord Length, width & height: +-0.16%

Curvature: +-7mm of the specified curve

Bonded panels and Tanks

Thickness:	+10% to -5%
Cord Length, width & height:	+-0.16%
Angles:	+-2% of the specified angle (unrestrained standing on its edge)

Bond Joint Specifications

- Bonded joints must be structurally sound, with a minimum safety in accordance with our design criteria.
- Bond joint must be free of any inclusions, which significantly decreases its structural performance.
- Bond joint must be watertight.
- Bond joint will be free of voids on the exterior surface.
- Bond joint will be free of any rough, or sharp protrusions, on the interior surface.
- Inclusions, bubbles, discoloration, and/or distortion in the bond joint or adjacent areas not visible after installation, or covered by facade, are not considered.

Bond Types and Grades

Quality description	Grade of Bond	
	Horizontal Bonds	Vertical Bonds
Commercial	Standard	Standard
Display	Display	Display
Aquarium/Museum	Display	Aquarium

Inclusions

Oversized inclusions may be removed and the panel repaired providing that all material physical property requirements, and optical performance requirements are met after completion of the repair(s).

Grade	Max No. of Inclusions	Removal of inclusion	Inclusions	
			Considered	Unacceptable
Standard Bond	7/m	Yes	>3mm long and where 2 dimensions are > 10x10mm	>4mm long and where 2 dimensions are >20x20mm
Display Bond	4/m	Yes	>3mm long and where 2 dimensions are > 6x6mm	>4mm long and where 2 dimensions are >12x12mm
Aquarium Bond	3	No	>2mm long and where 2 dimensions are > 3x3mm	(>3mm long and where 2 dimensions are >6x6mm) or > 14mm long

Annealing

All bonds will be annealed (unless stated otherwise) to minimise the internal stresses and to complete the chemical bond reaction. This will improve the structural performance and the crazing resistance of the bonded panels.

Optical Criteria

Acrylic viewing panels shall be virtually free of haze, distortions, or inclusions, which significantly diminish the viewing quality of the window.

Haze may be some form of contamination trapped within the panels or resulting from incomplete polymerisation. If visible from a distance of more than 1200mm perpendicular to the panels face the fault will be considered against the inclusion criteria.

Distortions are surface irregularities such as bumps, dimples, ridges, or waviness. A performance inspection utilizing a grid board and lights will be conducted to determine viewing panel acceptability. The procedure for this inspection is detailed below. Inclusions may be a piece of dirt, stone, grain of sand, hair, fibre, bubble or any other foreign material within the panel itself. In inspecting a panel, the central portion (an area equal to approximately 66% of the total panel viewing area is considered.

Grade	Max No. of Inclusions	Removal of inclusion	Inclusions	
			Considered	Unacceptable
Standard Panel	3/m ²	Yes	>3mm long and where 2 dimensions are > 10x10mm	>4mm long and where 2 dimensions are >20x20mm
Display Panel	1/m ²	Yes	>3mm long and where 2 dimensions are > 6x6mm	>4mm long and where 2 dimensions are >12x12mm
Aquarium Panel	0.35/m ²	No	>2mm long and where 2 dimensions are > 3x3mm	(>3mm long and where 2 dimensions are >6x6mm) or > 14mm long

Optical Test Specifications

The panel/tank viewing area will be visually checked against a black background with a white/silver mesh grid between the background and the viewing panel to the specification below.

Panel viewing area: Centre 66%
Viewing distance: 1000mm
Viewing Angle: Perpendicular to the surface +-15°
Background Colour: Black
Mesh Colour: White or silver
Mesh Density: 25mm

Tunnel section or curved/flat (wet side of a window): No distortion > half a grid square grid line must not be broken.

Flat or curved window (dry side): No distortion > quarter grid square grid line must not be broken.

All technical information and data is given as a courtesy only. Alternative Plastics Ltd. Assumes no obligation or liability for the accuracy of this information. If the customer deems it necessary all values, calculations and information should be confirm by a qualified structural engineer.