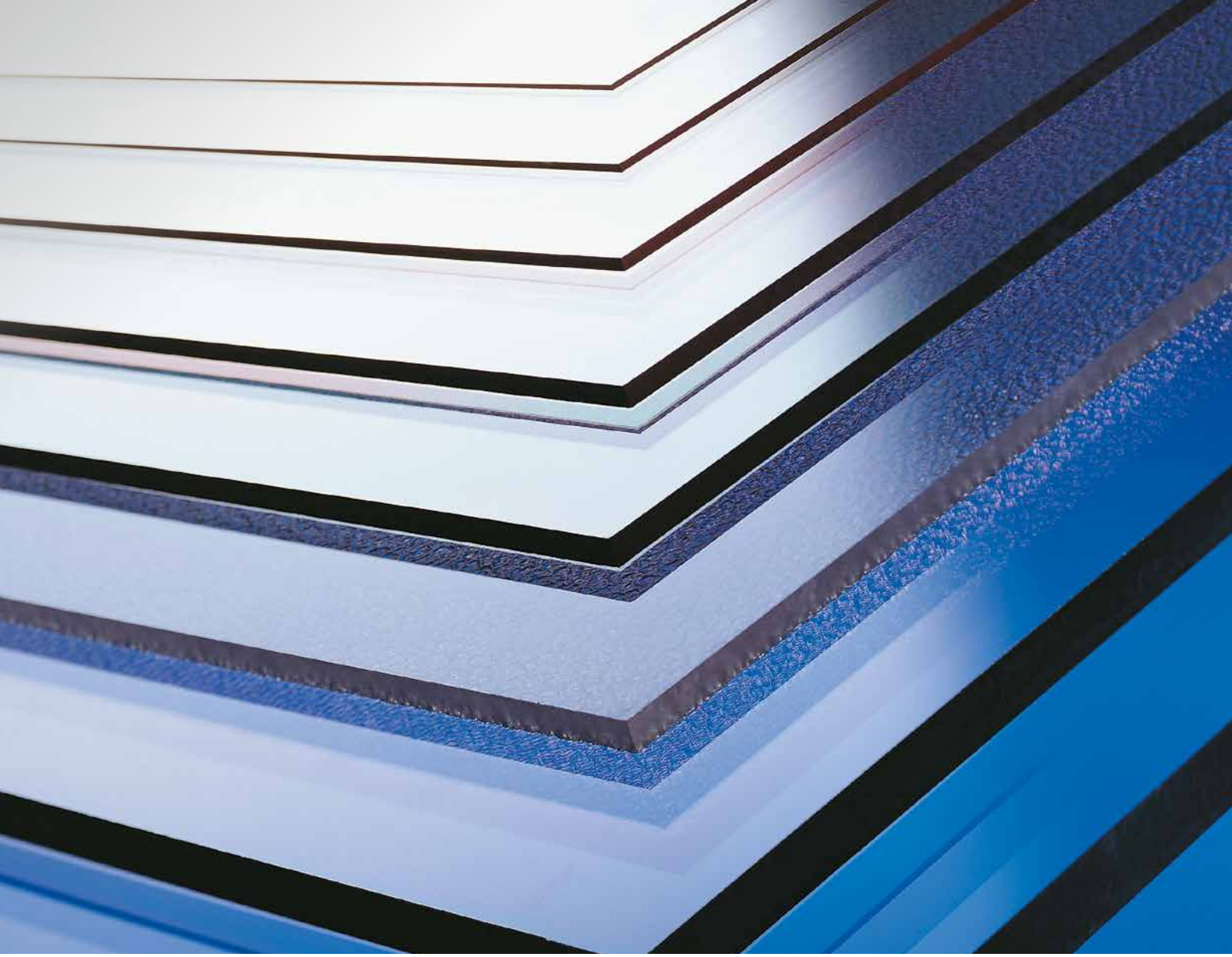


Technical Guide

Marlon FS

Brett Martin

Products
Marlon FS
Marlon FS Hard
Marlon FSX

Description
Extruded
Polycarbonate
Flat Sheet Range

Products that work

Brett Martin is a privately owned world class industry leader and manufacturer of specialist plastic products for the construction, fabrication, print and display sectors. Our plastic sheet range encompasses multiwall sheets and systems, corrugated sheets, transparent flat sheets and opaque PVC flat sheets.

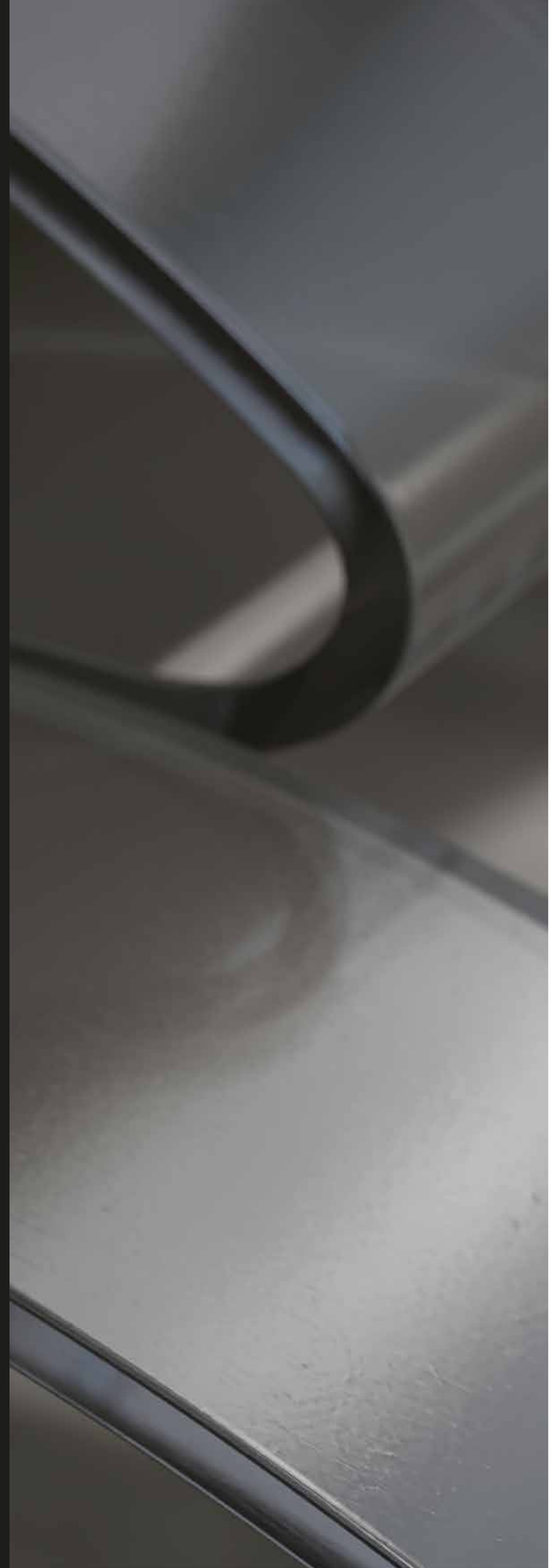
This Technical Guide relates to the Marlon flat sheet range which includes Marlon FS, Marlon FSX and Marlon FS Hard. Further details can be found at www.brettmartin.com.

Important note on semi-finished materials
Since the end uses of semi-finished materials are so diverse it is the responsibility of each user of Brett Martin's Marlon Sheets to make their own tests to determine the material's suitability for the particular application.

All the information is given in good faith but without commitment and warranty given or implied. Brett Martin accepts no liability for defects, loss or damage resulting from misuse, improper installation, inappropriate specification or any other factor beyond its control.

In accordance with our company's policy of continual product development, you are advised to check with your local Brett Martin representative to ensure that you have obtained the most up to date information.

Brett Martin



Contents

Product Range

Marlon FS flat polycarbonate sheet offers a unique combination of material properties that makes it superior to other thermoplastic materials or glass, making it the ideal product for roofing, glazing and fabrication.

It offers unbeatable impact resistance, providing protection against breakage and shattering. It easily withstands a blow of a hammer, hence it is extremely suitable for use in safety glazing applications, in vandal prone areas or in applications which require enhanced shatter resistance protective screening.

Marlon FS is available in a range of clear, translucent, opal, embossed and colour tinted options that offer different levels of light transmission and solar radiation. The embossed finish prevents glare due to the uniform dispersion of light over a large area, obscures views for added privacy and reduces visibility of scratches.

Product	Product Description
Marlon FS	Flat sheet polycarbonate
Marlon FSX	Flat sheet polycarbonate with UV Protective Coating on 2 sides
Marlon FS Hard	Flat sheet polycarbonate with Abrasion and Chemical Resistance Coating on 1 or 2 sides

Marlon FS

Marlon FS provides high impact resistance without compromising light transparency which is similar to glass. Yet at only half the weight, it's easier to handle and install and remains flexible enough to be thermoformed, cold bent or fabricated offering brilliant design flexibility.

Marlon FSX

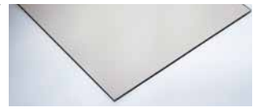
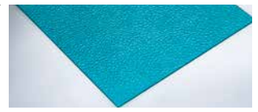
Marlon FSX flat polycarbonate offers a co-extruded UV protective layer on both sides of the sheet which protects against damaging UV radiation. As a result it can be used in the toughest climate conditions with enhanced protection against the effects of weathering and UV radiation, increasing sheet life expectancy and durability.

Marlon FS Hard

Marlon FS Hard has an abrasion and chemical resistant coating making it ideal for the toughest glazing environments – high traffic areas where marks and scratches are inevitable, as well as areas where there is the potential for vandalism and graffiti.

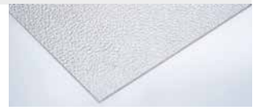
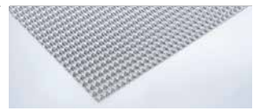
Colour/Tints

Marlon flat sheet polycarbonate is available in a range of colour tinted options that offer different levels of light transmission and solar radiation.

Colour	Description	Light Transmission	
Clear	Similar light transmission to glass, between 88-90% natural daylight. Ideal for architectural and vertical glazing projects and safety and security applications that require high levels of transparency.	High	
Bronze	Transmits between 50% - 54% light. Ideal for those projects that don't need complete transparency but still require visible light.	Medium	
Opal	Transmits 30-34%. Ideal for those projects that don't need complete transparency but still require visible light.	Medium	
Specials*	Green, Blue and Grey are also available upon request.	Medium	

Textures

Embossed finishes prevent glare due to the uniform dispersion of light over a large area. They obscure the view for added privacy and reduce visibility of scratches. All colours can be provided with an embossed finish.

Texture	Description	
Embossed	A shallow irregular texture on the surface of the sheet.	
Crushed Ice	A deeper irregular texture with a slight glistening effect.	
Diamond Embossed	A deeper, stronger and more uniform diamond pattern than standard embossed finish.	
Anti-reflective*	A light surface texture which prevents glare.	

*Subject to request. Minimum order quantities may apply. Please contact Brett Martin for further information.

Product Range

Marlon FS BioPlus

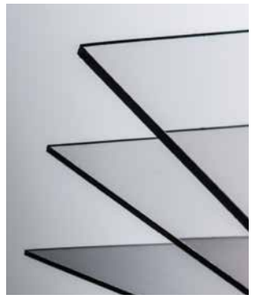
Marlon FS BioPlus, made with bio-circular attributed resin, is available across the entire Marlon FS range. Its material and processing properties are identical to the standard product.

Other Options

Option	Description
Strong Adhesion Film (SAF)	Strong Adhesion Film offers an adhesion level three times that of standard film. It is aimed at high-end engineering and fabrication projects that require extra protection during repeated processing, including drilling, 3D milling, warm & cold bending, thermoforming and cutting. The film is glue-free making it suitable for warming bending or thermoforming. It is easy to remove, even after thermoforming, without leaving a residue.

Standard Dimensions

Product	Sheet Size (mm)	Sheet Thickness (mm)
Marlon FS	1220 x 2440 1250 x 2050 1250 x 2500 2050 x 3050	3, 4, 5 & 6 0.5, 0.75, 1, 1.5, 3, 4, 5 & 6 0.5, 0.75, 1 & 1.5 2, 3, 4, 5, 6, 8, 10, 12 & 15*
Marlon FSX	1220 x 2440 2050 x 3050 2050 x 6110	2, 3, 4, 5 & 6 2, 3, 4, 5, 6, 8, 10, 12 & 15* 3, 4, 5, 6, 8 & 10
Marlon FS Hard	2000 x 3000	2, 3, 4, 5, 6, 8, 10 & 12



*Subject to request. Minimum order quantities may apply. Please contact Brett Martin for further information.

Quality

Manufactured under ISO 9001:2015. Please contact us for most up to date certification.

Application Areas

Design Versatility

Marlon can be used in a range of both internal and external applications. The material is easily processed and can be transformed in a variety of different ways to create endless fabrication possibilities. Applications such as:

Marlon FS

- Vertical glazing for internal applications e.g. partitions
- Safety and security glazing
- Machine guards
- Protective screens
- Visors
- Vending equipment
- Signage
- Illuminated signage
- Displays
- Poster covers
- Light fixtures

Marlon FSX

- External applications requiring UV protection
- Vertical Glazing
- Curved and flat rooflights
- Architectural roofing
- Sunrooms
- Canopies
- Covered walkways
- Sound barrier walls
- Exterior signage, including illuminated signage
- Bus shelters

Marlon FS Hard

- Safety and security glazing
- Anti-vandal glazing
- Display anti-graffiti protection
- Protective visors
- Police/security shields
- Prison windows
- Bus shelters
- Telephone kiosks
- Train windows
- Guard rails
- Sound barriers
- Industrial and architectural applications that require impact/ scratch resistance and graffiti protection

Product Features & Benefits

Marlon FS

- Excellent impact resistance – 200 times greater than glass
- Lightweight - half the weight of glass
- High natural light transmission
- Optically clear
- Thermally insulating
- Offers design flexibility
- Suitable for thermoforming
- Ability to cold curve
- Easy to handle, install and clean
- Excellent fire performance
- 100% recyclable

Marlon FSX

- Enhanced protection against the effects of weathering and UV radiation
- Excellent impact resistance – 200 times greater than glass
- Lightweight - half the weight of glass
- High natural light transmission
- Optically clear
- Thermally insulating
- Offers design flexibility
- Ability to cold curve
- Easy to handle, install and clean
- Excellent fire performance
- 10 year warranty
- 100% recyclable

Marlon FS Hard

- Double sided advanced abrasion resistance
- Enhanced protection against vandalism and graffiti
- Excellent impact resistance – 200 times greater than glass
- Lightweight - half the weight of glass
- High natural light transmission
- Optically clear
- Thermally insulating
- Offers design flexibility
- Easy to handle, install and clean
- Excellent fire performance
- 5 year warranty
- Can be recycled as a mixed plastic

Storage & Disposal

Surface Protection

All Marlon sheets are covered by a protective polyethylene film. This surface protection is applied to both sides of the sheet and can be removed easily.

All Marlon sheets are stacked on pallets at the end of the production line. The pallets are covered with stretch-wrap film and strapped to ensure they are received by the end user in pristine condition. The sheets should be similarly protected or packaged at all stages of processing to ensure the quality of finished items.

Storage

Marlon Polycarbonate sheets should be stacked horizontally, preferably on a continuous non-abrasive, flat, dry surface. Standing sheets on ends or sides, even for short periods, should be avoided.

Sheets can be placed on suitably constructed pallets or timber bearers at least 150mm wide spaced at intervals not exceeding 250mm. The pallet or timber bearers must be able to support the total weight of the sheets without distorting as this could, in turn, lead to distortion of the sheet during longer storage periods.

Stack heights should not exceed 1m. Sheets of differing lengths should not be placed on the same stack and standing sheets on ends or sides should be avoided. Pallets should be stacked no more than three pallets high.

Always store indoors where possible, raised from the floor or ground, under ambient warehouse conditions, away from direct sunlight, in a cool dry store up to 20°C. Do not store close to heat sources, for example, radiant heaters or boilers.

If storage outdoors cannot be avoided then, particularly in the case of on-site storage while building construction progresses, a secure storage site should be provided, well away from foot traffic, vehicle traffic and ongoing construction work. All sheets stored outdoors must be covered with a reflective, opaque, waterproof cover. Secure all covers to prevent the ingress of sunlight, wind and rain.

It is recommended that the original packaging is kept in place during storage and after the pallet has been opened.

The temperature of uncovered stacked sheets in direct sunlight can rise to levels which will be detrimental to the material. The presence of moisture between sheets can add to damage.

Excessive temperatures during transport and storage can cause the protective film to become firmly adhered to the surface making it difficult to remove.

Handling

Appropriate personal protective equipment should be worn when handling sheets as edges can be sharp and large/thick sheets are heavy.

When carrying, sheets should be turned on edge and held top and bottom. It will require more than one person to carry a large sheet or panel. Particular care should be taken with panels which have been processed, for example, screen printed. Use caution when handling large sheets in windy conditions.

Sheets and cut panels should not be dragged off a stack but lifted up directly and set down directly. Surfaces on which sheets are set must be clean to avoid damage.

Safety

REACH (both EU and UK variants) define these products as “articles” and as such do not require formal Safety Data Sheets. This information is issued to support our customers and this product group in their particular markets. All products are compliant with both EU and UK REACH legislations in their current forms, and with the latest RoHS directive. Please contact the Technical Department for full PSDS (Product Safety Datasheet).

Disposal/Recycling

Recycling
Thermoplastics are an important and valuable material so it is advantageous both in material and contract cost to establish well-managed processing and finishing procedures that minimise waste and scrap, and maximise recovery of what is unavoidable. At the end of the product’s life cycle Marlon Polycarbonate sheets are 100% recyclable and reusable if separated from other materials.

Off Cuts
Sheet off cuts produced by cutting and trimming to size as part of the installation process or panels which have been mechanically damaged, but have been kept free of contamination by dust or dirt, may be recycled into lower grade or non-transparent products. The appropriate disposal route is through a specialist plastic recycling contractor.

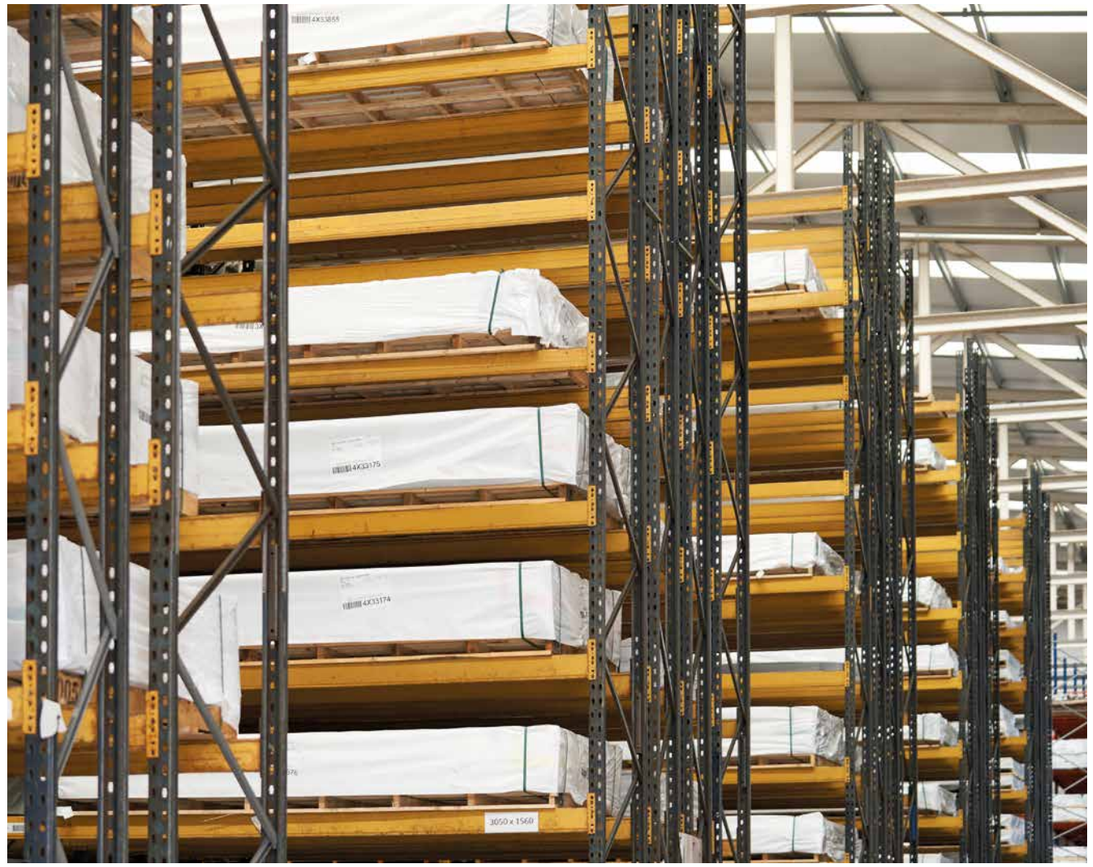
Waste Material
Sheet off cuts that have been contaminated by dust, dirt or other materials, which cannot be totally removed, generally need to be granulated and compounded in order to remove contaminants and to restore the material to a usable form.

Energy Recovery
Energy recovery is a valuable alternative for plastics which cannot be sustainably recycled. Modern combined heat and power recovery plants (CHP Plants) can use waste plastics together with other high calorific input materials. This provides a valuable source of heat and power which can contribute to energy needs. Such energy recovery processes use only the best available technology to ensure they are safe, environmentally-responsible and efficient installations.

Landfill
As a last resort Marlon Polycarbonate can be safely disposed of in landfill alongside domestic waste if local regulations are observed. All Brett Martin products are lead-free and comply with current REACH legislation.

Combustion
Marlon Polycarbonate should not be incinerated unless done professionally. Smouldering and incomplete combustion may cause toxic fumes and soot particles.

Marlon FS Hard
Due to the abrasion and chemical resistant coating on Marlon FS Hard products it should be classified as a mixed plastic.



Fabrication

Marlon is an easy material to work with using basic wood and metal working tools. When working with any power tool, the sheet temperatures must be kept below the **material softening point of 148°C**. Polycarbonate is a thermoplastic and excessive heat build-up can result in deformation, softening and surface deterioration or discolouration of the sheet substrate. Compressed air is a suitable and easy to apply coolant.

Efficient removal of dust and swarf from the cutting tool also helps to lower temperatures as well as contributing to a good quality cut finish. It is also necessary to have an effective means of removing dust produced by machining operations from the operator's environment.

In general, machining operations require a combination of low feed speed and depth of cut together with a high cutting speed. Correct tool geometry is also important. The recommendations given for tool geometries and speeds should be used as a guide: some experimentation may be required to obtain best results.

Computer Controlled Cutting

It is possible to cut the Marlon flat sheet range with water jet, however, water does not permit high cutting speeds and fails to provide glossy cut edges.

There are two alternatives:

- Cutting with a clear water jet - only possible up to 3mm. The edges become somewhat frayed.
- Cutting with water containing abrasives - possible with higher thicknesses up to and including 10mm. The cut edges look as if they have been sanded.

The feed rate to be selected depends on the material thickness, the desired quality of the cut and the abrasive grain.

Sawing

Polycarbonate flat sheet is easy to saw and cut on standard workshop equipment. It can be machined on conventional milling machines with standard high speed tools.

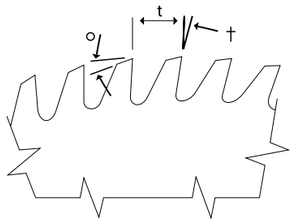
Safety First
Due to the high rotational speeds it is very important that:
- All protective devices are in good working order and that they are being used;
- All prescribed personal safety equipment is being worn at all times.

Blades designed for cutting plastics are ideal for cutting Marlon, as are most types of wood saws – band, bench, circular, hand, jig and wall saws. Blades must be sharp, with a slight side set.

Hold and support sheets to avoid stress and vibration, particularly in cold conditions. Blunt blades and very fine tooth metal cutting blades, or incorrectly held material, produce an unsatisfactory finish.

When using power saws, clear swarf and avoid heat build-up at the cut to produce clean cuts.

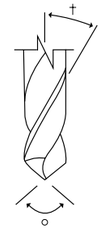
See below for guidelines of pitch, clearance angle and feed speed to obtain a good quality cut from band and circular saws and milling machines.



Recommendations	Circular Saw	Band Saw	Milling Machine
Clearance Angle (o)	20 – 30°	20 – 30°	20 – 25°
Rake Angle (†)	15°	0 – 5°	0 – 5°
Cutting Speed	1800 – 2400 m/min	600 – 1000 m/min	100 – 500 m/min
Feed Speed	19 – 25 m/min	19 – 25 m/min	0.1 – 0.5 mm/rev
Tooth Spacing (t)	2 – 5 mm	1.5 - 2.5 mm	-

Drilling

When drilling Marlon FS flat polycarbonate sheets, metal drills without a specially ground bit can be used, though a thermoplastic specific bit would be preferential. Do not use cutting oils.



Parameter	Value
Clearance Angle	5 – 8°
Tip Angle (o)	90 – 130°
Helix angle (†)	Ca 30°
Rake Angle	3 – 5°
Cutting Speed	0.1 – 0.5 mm/rpm
Drill Tip Speed	10 – 60 m/min

Do not use cutting fluids as this can chemically attack the polycarbonate.

Sharpened tools provide the best finish; HSS double-edged cutters are preferred, ground and honed with a back clearance angle of 12° or greater, although standard bits can also be used successfully. For thinner materials fluted cutters are preferred.

Avoid countersinking fixings and always use fixing threads if there is no alternative. Holes should be at least 1.5 x hole diameter from the edge of the sheet.

Finishing

Sheet edges can be finished by filing, sanding, grinding, planing or using a deburring tool, for example, a flat steel edge scraper. Such finishing operations on the sheet surfaces may remove the UV protection or abrasion resistant coating which may be undesirable in some applications. For more information on edge finishing, see page 16.

Countersinking fixing is not recommended.
Holes should be a minimum of 1.5 x hole diameter from the edge of the sheet. The hole diameter should be a minimum of 6mm larger than the fixing shank diameter for sheets up to 2m and an additional 3mm per metre length thereafter.

Milling & Routing (CNC)

It is easy to router either with hand held or CNC machines. Marlon FS can be machined on conventional milling machines with standard high speed tools. Notches adversely affect the mechanical properties of polycarbonate and should be avoided as these lead to cracking at a later stage. It is important that the part to be machined is securely held to prevent any vibration which would lead to a poor finish.

Cutters	Spindle Speed
6-12mm diameter or less	Ca 24000 rpm
>12mm	Ca 18000 rpm

Light cuts are required to prevent the part from overheating. Overheating the polycarbonate can cause stress which may result in cracking the surface. Cooling the cutting tool and part with compressed air is typical and has the additional benefit of removing swarf.

Forming

Thermoforming

Before thermoforming, remove masking films and pre-dry at 120°C to remove absorbed moisture. Air circulation ovens with accurate temperature control are most efficient. Air must circulate between sheets. Sheet age and storage conditions determine drying time. Dry storage can reduce pre-drying time in the oven by up to one third - some experimentation is usually necessary. As moisture re-absorption starts when the dried sheet temperature falls below 100°C, thermoforming should be performed immediately after drying.

NB.
Marlon FS Hard is NOT recommended for thermoforming.

Sheet Thickness (mm)	Drying Time* at 120° (hr)
0.75	1
1	1
1.5	2
2	4
3	8
4	13
5	18
6	24
8	28
10	30
12	33
15	37

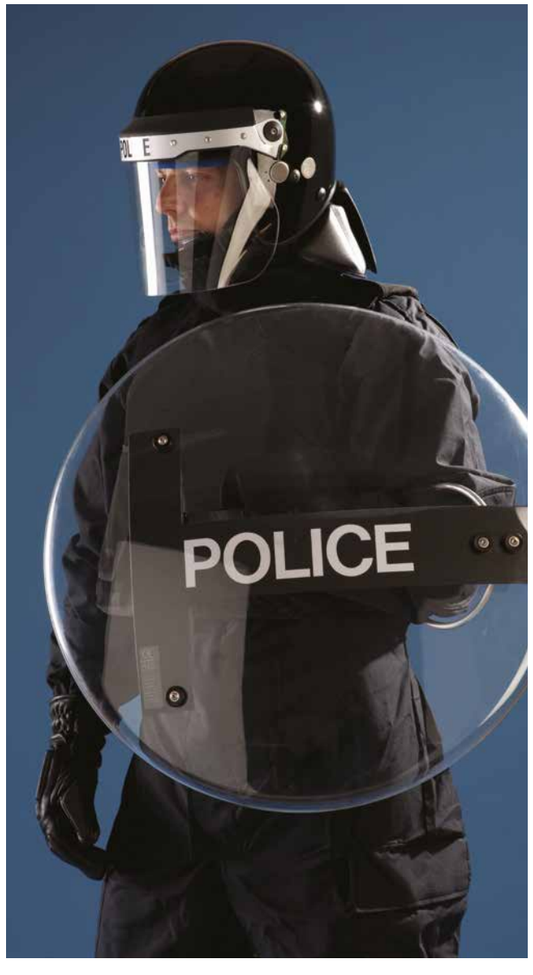
*Approximate: drying time may vary depending on storage conditions.

Marlon FS flat sheets can be moulded on any standard vacuum or pressure forming equipment. Forming can be made at temperatures between 175°C and 200°C. When the mould temperature falls below 125°C formed parts can be removed. Mould shrinkage will be between 0.5% and 1.0%.

Vacuum Forming

Components that are relatively simple and shallow in form are thermoformable from sheet heated to an elastic state.

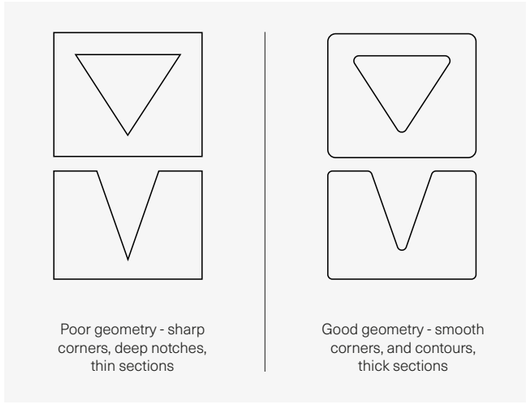
Most industrial press and vacuum formers for thermoplastics are suitable. Best results are achieved from machines that control heat on both sides of the sheet. Large area panels and thick panels need some air pressure support during heating to avoid sag. Male moulds are suitable for vacuum forming and female moulds are suitable for both vacuum and pressure forming.

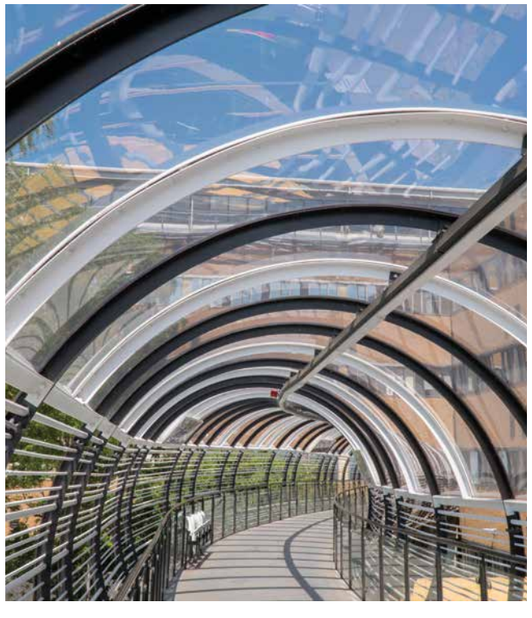


Component Geometry

Sharp corners and notches in thermoplastic components assist in the initiation and propagation of cracks, particularly if a component is under stress. Creases, grooves and sharp bends also form potential weaknesses. Component shapes should exclude such features. All internal and external corners or changes in direction should follow a smooth radius profile.

Where designs involve hot bending of sheets, radii should ideally be no less than two and half times the sheet thickness.





Cold Curving

Marlon FS flat sheets can easily be cold curved. The minimum allowable radius for cold curved applications is the thickness of the sheet x 150. However, at low radii, high stresses are built up in the material which will lower chemical resistance. For good design practice it is advisable to limit the minimum radius to 175x the sheet thickness. This incorporates a factor of safety to cope with the stress effects produced by curving and environmental stress factors. The table below shows the recommended minimum radii for various thicknesses.

Thickness (mm)	Min Radius (mm)
2	300
3	450
4	600
5	750
6	900
8	1200
10	1500
12	1800
15	2250

Marlon FS Hard should not be cold curved below 1500mm radius for all thicknesses up to and including 10mm. For large installations refer to curved installations on page 22.

Hot Line Bending

Pre-drying is not normally required. The recommended temperature is between 155°C and 165°C. The area of material to be heated must be approximately five times as wide as the sheet thickness. Up to and including 4mm thick can be bent when heated from one side only. Over 4mm it is necessary to heat the sheet from both sides. Bending sharp internal corners should be avoided. Always use a former radius at least equal to the sheet thickness.

Bonding & Welding

Bonding

Marlon FS can be bonded to itself or to other materials using commercially available adhesives suitable for polycarbonate. The following factors should be considered when selecting an adhesive for a particular application: heat resistance, elasticity, appearance (opaque/translucent), loading and ease of processing.

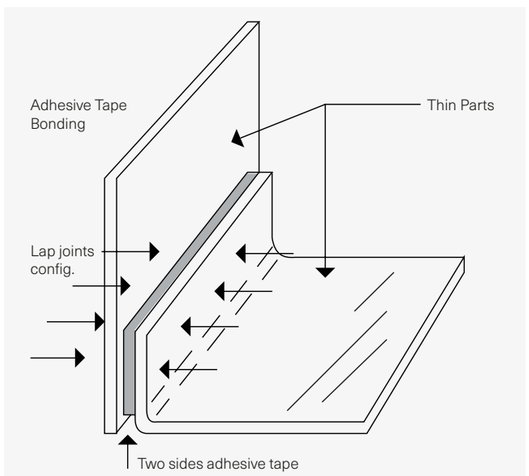
The joint faces must be cleaned prior to bonding (see page 24 for cleaning recommendations) and free from oil or grease.

If Marlon FS parts have undergone secondary processes, thermoforming, line bending, milling etc. it is recommended that the parts be annealed to release stresses prior to bonding in order to avoid stress cracking or surface crazing.

The user should satisfy themselves, preferably by testing, that any adhesive or bonding material will be suitable for the specific application and compatible with polycarbonate. The user should at all times follow the adhesive manufacturer's recommendations as to suitability, surface preparation, use of primers, application methods, curing times and conditions to be satisfied for effective bonding. Manufacturers' health and safety precautions must also be observed.

Tapes

Acrylic based foam tapes can be used for rapid mounting or lap joints adequate for bonding small components. Use a roller and apply even pressure to remove any air bubbles and improve adhesion.



Adhesive Bonding

Adhesive bonding is useful for gap-filling bonding and provide a more flexible bond.

Marlon FS can be bonded using one of the following adhesives: Epoxy, Polyurethane, Hot Melt or Silicone. Ask your adhesive supplier for the most appropriate type of adhesive for your particular application.

Solvent Bonding

Use extreme caution when working with solvents: They may be toxic or contain carcinogens. Adequate ventilation is essential. Obtain Safety Data Sheets from the solvent manufacturer.

Solvents such as Methylene Chloride provide a good bond but can lead to stress cracking and are therefore not recommended. Solvent bonding should only be performed by highly skilled operators. It is not recommended to use solvent bonding for bonding two different substrates. Adhesive bonding is more appropriate in this case.

Joint Design

The joint details should be considered carefully, verifying that the bonding area spreads the intended loads equally, and the major stresses are either in tension or shear, so as to minimise separation and peel stresses.

Welding

Although Marlon polycarbonate can be successfully welded using various techniques, it can be problematical and for this reason it should be carried out by specialists. The strength of the finished weld may be only 35 to 45% of the standard material.

There are high tensile stresses generated in the weld area as the material cools. Annealing must be used to relieve these stresses otherwise the resultant construction can be brittle and prone to chemical attack resulting in crazing. See page 16.

Hot Gas Welding

Pre-drying of the components and the filler rod is advisable to prevent 'bubbles' forming in the joint.

- Filler rod 2 mm to 4 mm square or round section Marlon FS.
- Hot gas temperature (air) 400 to 500°C.
- Welding pressure 2.8 N/mm^2
- Welding speed 150 to 200 mm/min
- Nozzle to weld distance 15 mm
- Nozzle diameter equal to the seam width
- Air Quantity 25 l/min

The parts to be welded are normally horizontal but other orientations are possible. The filler rod should be introduced perpendicular to the chamfered grove between the parts at a constant pressure. The welding nozzle fans across between the joint and the filler rod.

Hot Plate Welding

The polycarbonate parts should be pressed against a hot plate at 400°C until they are sufficiently soft and formable. The contact areas should be matched to the heated plate. The parts are then pressed together until molten material is squeezed out of the joint. The pressure must be maintained until the material has solidified. This is normally carried out using suitable jigs. The hot plate should be Teflon coated in order to prevent material sticking.

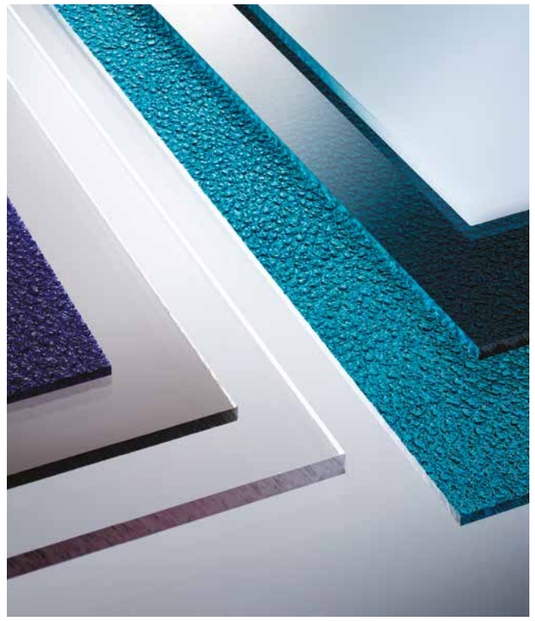
Finishing/Graphics Applications

Marlon FS is a suitable substrate for a range of graphic applications creating moisture resistant, lightweight Point of Sales (POS) displays, and interior and exterior signage including illuminated signage.

Edge Finishing

After fabrication, cut edges of Marlon FS/FSX can be polished to improve the finish and aesthetical properties. There are different techniques used in polishing the edge including mechanical and diamond polishing.

Only the edge of Marlon FSX/FS Hard sheet should be ground or polished as the protective UV layer or anti-abrasion coating can be damaged if the surface is machined.



Annealing

Annealing should take place to remove the stress generated by welding, line bending or milling. Marlon FS should be heated to 80 to 95°C for at least 8 hours. The part should then be cooled slowly. The time in hours should be the material thickness divided by 4. The cooling rate must not exceed 15°C per hour. The part must be cooled to below 60°C before removal from the oven. Annealed parts may experience heat reversion and dimensional changes must be taken into consideration.

Printing & Painting

The surface of Marlon FS is suitable for a variety of graphic design process including digital flatbed printing, screen printing, painting and varnishing. It is important to select the correct ink/paint with the end application in mind and always follow the manufacturer's instructions.

The sheet's protective film should remain on until just before printing/painting. Only a static brush or ionisation is therefore required to remove static build up and ensure a quality print.

Static is common with all insulating materials. To discharge, rinse the surface with water or antistatic cleaning agent, or blow down the sheet with ionised air. The effect of this treatment is short term but usually sufficient for subsequent operations. An effective method to reduce static build up is to control the relative humidity - the higher the relative humidity, the lower the static charge.

Recommendations:

- Use only recommended paints, inks and thinners.
- Do not mix different paints and inks.
- Do not substitute toluene, xylene, cellulose acetate, methylethylketones or other solvents for the recommended thinners.
- Provide good ventilation during drying periods.
- Follow the paint/ink manufacturer's recommendations at all times especially items relating to health and safety.

Printing on the UV coated surface of Marlon FSX invalidates the warranty on the coating. Printing cannot be carried out on Marlon FS Hard's coated surface as the abrasion resistant coating will prevent permanent paint/ink adhesion. Marlon FS Hard with the coating on one side only is available on request, allowing for reverse printing. For further details and advice on these processes please contact our Technical Department.

Vinyl Graphics

Decorative and lettering / script graphics can be applied to Marlon FS as the material forms a very rigid and stable substrate. The surface quality ensures excellent results free from visual distortion. All materials used in the application process must be dust and moisture free to avoid surface bumps and blisters. Application pressure must be even and strong enough to expel air from the vinyl but excessive pressure can lead to distortion of the graphic and may cause wrinkles.

Mounting Photographs/Prints

Photo mounting to Marlon FS gives very high quality results due to the excellent surface finish and stability of the material.

Hand laminating is suitable only for small sizes and runs of panels. Laminating on a clear film protects the print or graphic surface while matt finishes can reduce glare.

Application of films which require high temperatures should be avoided as this could lead to buckling of the sheet. Once mounted, leave photographs/prints to rest on a flat, even surface until cured. Follow adhesive manufacturer's instructions.

Adhesive Film/Vinyl

The smooth, even surface of Marlon FS makes it the ideal substrate for lettering, films and vinyl graphics. The following points need to be considered when determining film type;

- Location (indoor/outdoor)
- Durability (period of use)
- Type of bond (permanent/removable)
- Processability (printing/welding)

Lamination

Laminating is a specialist process.
All sheets must be clean and dry before laminating. Polycarbonate can be cleaned with isopropyl alcohol. All material used in the laminating process must be dust and moisture free while pressure must be even and strong enough to expel air across the sheet width. Roller laminating machines are essential for larger sizes and volumes of panels as ideal roll temperatures, pressures and laminating speed can be determined and accurately controlled to suit the sheet thickness and the material being applied. Wrinkles/bubbles in the film are often caused by poorly aligned rollers or excessive roller pressure.

Laminating to Glass

There are two basic types of laminating for glass to polycarbonate: polyvinyl butyl (PVB) and resin lamination. Marlon FS is suitable for laminating to glass using a PVB interlayer or a liquid resin. Follow the manufacturer's instructions for the laminating equipment and materials.

General considerations
All sheets must be clean and dry before laminating. Polycarbonate can be cleaned with isopropyl alcohol. In some cases the polycarbonate may require a primer to protect it from the actions of the adhesives. The adhesive manufacturer should be consulted as appropriate about compatible adhesive, procedures and especially health and safety measures. The laminating layer must be sufficiently thick to allow the differential movement between the layers due to the different coefficients of expansion. Other glazing materials such as acrylic can be used in the laminate to provide a variety of properties for the finished glazing sheet.

Film lamination
The application of decorating foils or self-adhesive lettering or transfers is only suitable for flat or slightly curved sheets. It is recommended to use adhesive foils which do not produce stress in the sheet. Outgassing and evaporation may cause partial separation of the self-adhesive film. Therefore the sheets should be pre-dried overnight at a temperature of 70 - 80°C. Impurities such as dust particles can also lead to adhesion issues and produce flawed appearance. The sheet must be cleaned or heat treated before application to avoid stress cracks and adhesion problems. Preliminary tests are advisable.

Design & Installation

Thermal Expansion

Dimensional change can occur both in sheet length and width due to changes in temperature. This is known as thermal expansion. The coefficient of linear expansion specifies by how much a sheet of 1 metre in length expands if the temperature increases by 1 degree. Marlon flat sheets have a linear expansion coefficient of 0.068mm/m°C.

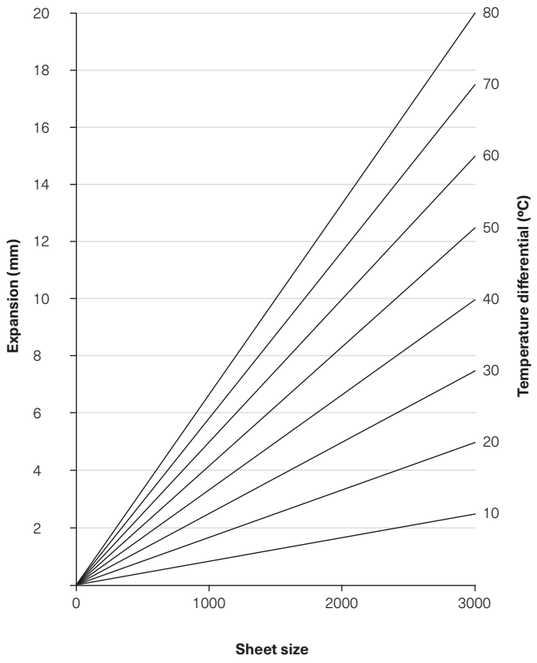
It is essential to consider the variations caused by Thermal Expansion when installing Marlon sheets both in indoor and outdoor applications. This movement must not be inhibited otherwise distortion, warping or localized buckling will occur, bearing in mind that expansion affects both the length and width of the sheet.

The service temperature range limits of Marlon are -20°C to +100°C, an overall temperature differential range of 120 degrees.

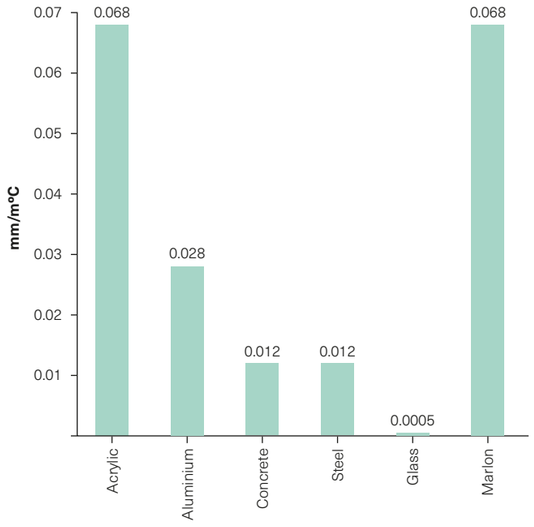
Marlon can be used in conjunction with many common building and accessory materials, the thermal expansion properties of which must also be taken into consideration. The graph below illustrates the relative coefficients for various materials. Marlon clearly expands much more than timber, concrete, brickwork and metals when their temperature is changed by the same amount.

For examples of thermal expansion please see Appendix 1.

Relative Expansion Coefficients



Relative Expansion Coefficients



Thermal Insulation

An advantage of Marlon FS/FSX/FS Hard is that they are more efficient at preventing heat loss than traditional glazing materials of comparable thickness. The U value is used to compare the insulation properties of materials. It measures the amount of heat passing through the material for a unit area for every degree of temperature difference across the material. Therefore the lower the U value the better the material will retain the heat within the building.

Sheet Thickness (mm)	Marlon FS range (W/m²K)	Glass (W/m²K)
0.75	5.76	-
1	5.72	-
1.5	5.64	-
2	5.56	-
3	5.41	5.87
4	5.27	5.82
5	5.13	5.80
6	5.00	5.77
8	4.76	5.71
10	4.55	-
12	4.35	-
15	4.08	-

Note K-Values vary depending on heat flow, size of panel, distance between sheets and number of sheets. Where "K" Kelvin is a unit measurement for temperature.

UV Stability/Exterior Signage

Outdoor applications expose the sheets to sunlight. This influences the sheet in three ways: changing the temperature, creating thermal movement and degradation of the surface.

Surface degradation, indicated by colour change or "yellowing", is slightly influenced by heat. However UV radiation from sunlight can have a much greater effect.

FS	No UV protection
FSX	UV on both sides as standard
FS Hard	UV on both sides as standard

Wind & Snow Loading

When designing an external application, loads should be estimated and provision made for secure means of fixing. Loading should be calculated using EN1991.

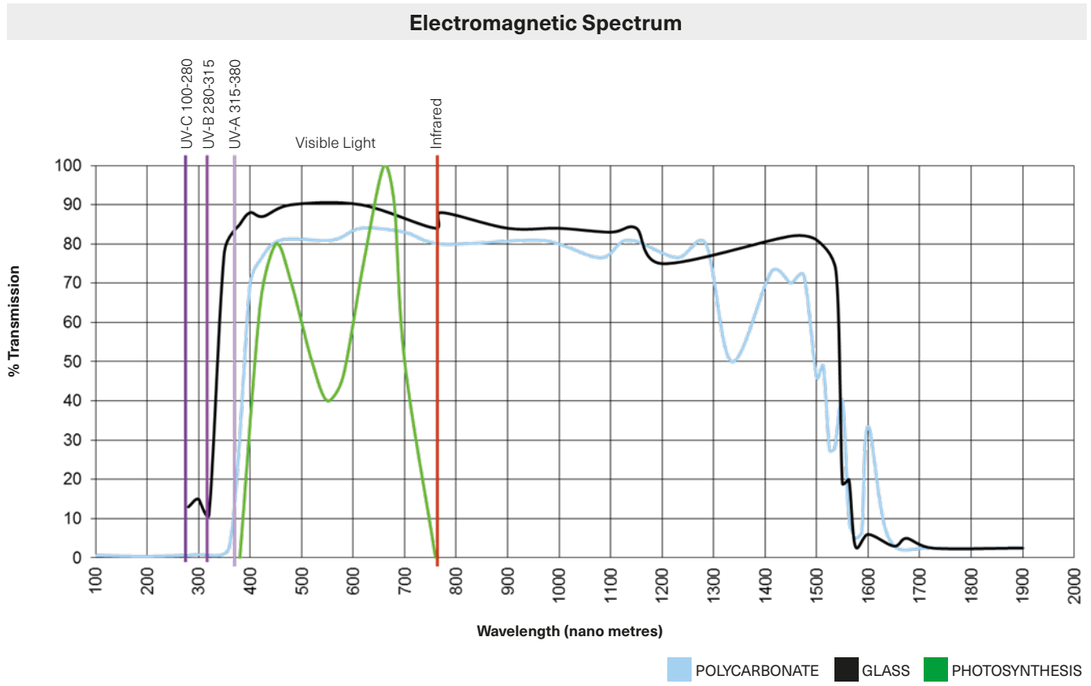
Sound Insulation

Airborne Sound Reduction Index to BS EN ISO140-3: 1995, BS2750: Part 3

Sheet Sound Reduction Index (dB)		
Sheet Thickness (mm)	**Marlon FS**	**Glass**
3	23	-
4	25	29
5	27	30
6	29	31
8	31	32
10	33	33
12	34	34
15	35	-

Design & Installation

Transmission Spectrum



- Polycarbonate curve represents transmission through Marlon FSX, clear.
- Glass curve represents transmission through 4mm clear glass.
- Photosynthesis curve represents medium spectral photosynthetic efficiency for plants with green leaves.
- All Marlon products block in excess of 98% of all UV wavelengths.

Material Properties

Properties	Marlon FS	Units	Standard
Density	1.2	g/cm3	ISO 1183-1
Transmission @3mm	90	%	ISO 13468-1
Flexural Strength	97	MPa	ISO 178
Tensile Strength @Yield	62	MPa	ISO 527
HDT	145	°C	ISO 75-2
Thermal Expansion	0.068	mm/m°K	ISO 11359-2
Service Temp - Long Term	-20 to +100	°C	
Service Temp - Short Term Unstressed	-40 to 130	°C	

Food Contact

Marlon FS/FSX are safe to use in areas where food is being prepared in a variety of applications such as glazing, wall cladding, etc.

Marlon FS/FSX are not suitable for use in food container/packaging applications or other types of application where it is in continuous direct contact with food.

Service Temperature

Marlon FS mechanical performance is known to remain stable for prolonged service in temperatures ranging from –20 to +100°C (Short term unstressed -40 to +130°C). Therefore it can be installed in a diversity of applications, with varying temperatures.

Fire Rating

The fire performance of Marlon FS/FSX has been independently tested. Contact Brett Martin's Technical Department for the most up to date certification.

Frames & Glazing

Marlon FS flat sheets can be installed in most types of frames including PVC, wood, steel and aluminium. The framing system must retain the sheet but allow thermal movement.

Only compatible sealants must be used, including silicone, EPDM, neoprene or 'plasticiser free' chloroprene materials of proven performance.

Please note that PVC gaskets are not compatible with polycarbonate.

Care must be taken when cutting sheets to allow space for thermal expansion to avoid stress or bowing with temperature change. Allowance must be made in both length and width. In vertical installations the expansion allowance must be taken into consideration at the top of the frame and at both sides.

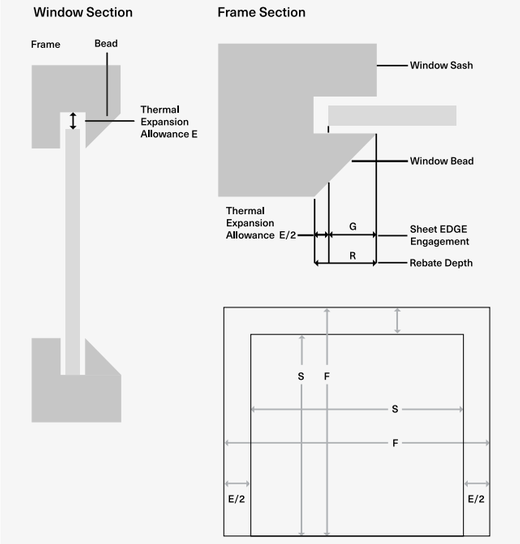
Edge Engagement

The design of the rebate must allow enough depth to include the expansion allowance yet provide sufficient sheet edge engagement to prevent the sheet popping out of the frame.

Sheet Sizing

The table below shows the required thermal allowance (or trim) for different window frame (sash) dimensions.

Sash Dimensions (mm)	Trim Marlon FS by 'E' (mm)
300-1000	3
1000-1300	4
1300-1700	5
1700-2000	6
2000-2300	7
2300-2700	8
2700-3000	9



Design & Installation

Sheet Thickness

The following charts indicate the required sheet thickness to ensure sheet deflection does not exceed a maximum of 50mm, assuming four side edge engagement. Having first calculated the effective area of the sheet, the required thickness for a given wind load can be selected. Guidance is also available from BS 5516.

Calculation of the effective sheet area

	Sheet Length (m)																			
Sheet Width (m)	**0.25**	**0.5**	**0.75**	**1.0**	**1.25**	**1.5**	**1.75**	**2.0**	**2.25**	**2.5**	**2.75**	**3.0**	**3.25**	**3.5**	**3.75**	**4.0**	**4.25**	**4.5**	**4.75**	**5.0**
0.25	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
0.5	A1	A2	A3	A4	A4	A4	A4	A4	A4	A4	A4	A4	A4	A4	A4	A4	A4	A4	A4	A4
0.75	A1	A3	A5	A6	A7	A7	A7	A7	A7	A7	A7	A7	A7	A7	A7	A7	A7	A7	A7	A7
1.0	A1	A4	A6	A8	A9	A9	A10	A10	A10	A10	A11	A11	A11	A11	A11	A11	A11	A11	A11	A11
1.25	A1	A4	A7	A9	A10	A11	A12	A13	A13	A14	A14	A14	A14	A14	A14	A14	A14	A14	A14	A14
1.5	A1	A4	A7	A9	A11	A13	A14	A15	A16	A16	A16	A17	A17	A17	A17	A17	A17	A17	A17	A17
1.75	A1	A4	A7	A10	A12	A14	A16	A17	A18	A19	A19	A19	–	–	–	–	–	–	–	–
2.0	A1	A4	A7	A10	A13	A15	A17	A18	A19	–	–	–	–	–	–	–	–	–	–	–

Selection of sheet thickness in mm

	Effective Area																		
Load kN/m²	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**	**A11**	**A12**	**A13**	**A14**	**A15**	**A16**	**A17**	**A18**	**A19**
0.6	3	3	4	4	5	5	6	6	8	8	10	10	10	10	10	10	12	12	12
0.8	3	3	4	4	5	6	6	6	8	8	10	10	10	12	12	12	12	12	–
1.0	3	4	4	5	5	6	8	8	8	10	10	10	10	12	12	12	–	–	–
1.2	3	4	4	5	5	6	8	8	8	10	10	12	12	–	–	–	–	–	–
1.4	3	4	5	6	6	8	8	8	10	10	12	12	–	–	–	–	–	–	–

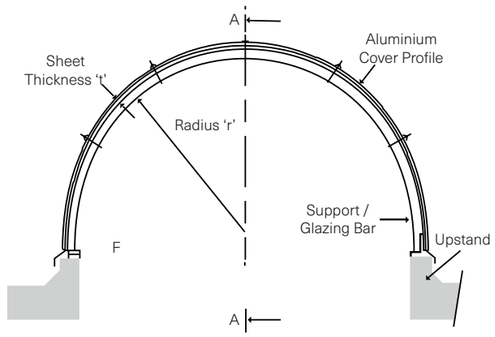
Curved Installation

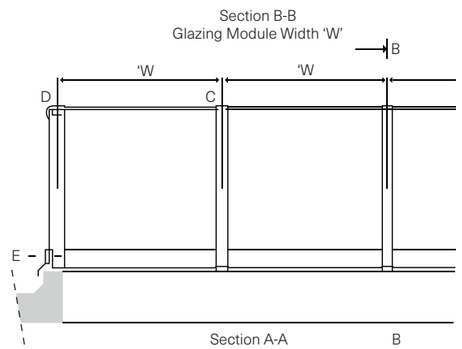
Marlon FS flat sheets can be installed in a curved glazing system on site, without prior forming. The thickness of sheet that must be used will depend upon the curvature and the span, the distance between glazing bars and the maximum load that will be applied to the sheets.

Each thickness has a minimum allowable radius, shown in the following table. Marlon FS Hard minimum radius for all thicknesses = 1500mm

A safety factor of 1.5 is applied in all cases.

Thickness (mm)	Min Radius (mm)
2	300
3	450
4	600
5	750
6	900
8	1200
10	1500
12	1800
15	2250





The critical load at which buckling will occur is a function of the geometry of the structure and the intrinsic properties of Marlon flat sheet.

In practice the sheet length, along the curve, needs to be at least twice the sheet width. The forces required to form and retain the curve can lead to mechanical damage and high residual stress If this geometry cannot be accommodated then thermoforming may be an option.

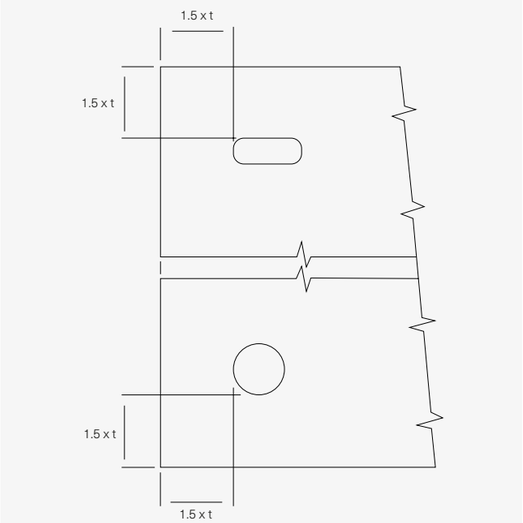
Point Fixings

Point fixing of Marlon FS is possible but allowance must be made for thermal expansion see page 18. Marlon FS should always be gasketed to the support frame, capping and washers using gaskets compatible with polycarbonate.

Fixing Hole, Slot & Washers
Fixing holes should never be closer than 1.5 x sheet thickness from the edge of the sheet. Always drill the hole larger than the diameter of the screw shank.

Avoid tightening the screws too much, but make sure the rubber washers seal the hole and fit smoothly onto the sheet, without applying too much pressure. Use continuous capping or large washers to spread the force at fixings.

Never use countersunk screws or rivets.



Cleaning & Maintenance

Cleaning

In order to preserve Marlon FS in a good condition and ensure optimum performance, it is recommended that the sheet is cleaned periodically using the following recommendations.

Dusty areas can be cleaned with water, a non-fluffy, lint free soft cloth or sponge but should never be rubbed when dry. Marlon Polycarbonate has good electrical insulation properties which may results in electrostatic charging and the attraction of dust particles.

Before any treatment of Marlon FS we recommend removing any dust on the surface by blowing with ionised air. Normal compressed air will just spread the particles around the surface.

The recommended cleaning instructions are as follows:

- Use lukewarm water to rinse and soften dirt.
- Make up a solution of lukewarm water and ordinary household cleaner or mild soap and use this to wash the sheet.
- A sponge or soft cloth should then be used to gently remove dirt and grime.
- For large areas a pressure washer may be used.
- Ethyl alcohol or isopropyl alcohol used sparingly can be used to remove paint, grease or other such substances. Note: Allow adequate time for evaporation as streaks can form unless completely dry.
- The cleaning process should then be repeated and the sheet rinsed with clean water and dried with a soft cloth.

Warning

The following precautions should be observed:

- Do not scrub the sheet with brushes.
- Do not use razor blades or other sharp tools.
- Do not use squeegees.
- Avoid sanding or grinding as this causes irreversible changes to the surfaces
- Avoid cleaners of a highly alkaline composition.
- Avoid cleaning in the hot sun or high temperatures.
- Liquid cleaners must be checked for suitability before use. They frequently leave residues, dull the surfaces (especially acetone) or embrittle the material, as many solvents contain a high level of aromatic components.
- Always follow manufacturer's instructions when using cleaning products.

Cleaning - Marlon FS Hard

Marlon FS Hard is an extruded polycarbonate flat sheet combined with an abrasion and chemical resistant coating. The highly resilient and abrasion resistant surface coating resists marks and scratches, vandalism, graffiti and physical attack and also withstands contact from a wide range of cleaning agents, organic solvents and corrosive elements.

In order to preserve Marlon FS Hard in a good condition and ensure optimum performance it is recommended that the sheet is cleaned periodically using the recommendations for Marlon FS. For graffiti removal see below.

Graffiti removal
Labels, Stickers etc:
Use white kerosene or white spirit.

Paints, Marker Pens, Ink etc:
Use graffiti removers as listed, always follow manufacturer's safety recommendations. Afterwards wash sheet with lukewarm soapy water and rinse with clean water.

Graffiti Remover Suppliers:
Although these products claim to be compatible with Marlon FS Hard polycarbonate Brett Martin Limited cannot be held responsible for any damage caused. Advice should be sought from the cleaning compound manufacturers as to their products' suitability for use on polycarbonate. We would recommend that a small inconspicuous area is tested first to evaluate the performance of the cleaning solution.

GR II
Ross Environmental Products Ltd
Unit 207 A
Foley Industrial Estate
Kidderminster
Worcestershire
DY11 7DH
Tel: 015 6275 2299
e-mail: sales@rossenvironmental.co.uk

Graffiti Go
Cellande
Cellande House
Gristhorpe Road
Birmingham
B29 7SL
Tel: 012 1472 2903
e-mail: enquiry@sellygreen.co.uk Vandalex

Chemical Resistance

In general, the chemical resistance depends on reaction time, temperature of application, pressure, purity and concentration of the reagents as well as mechanical stress and other influences. However, Marlon resists aqueous acids and saline solutions as well as oils.

Sheets will swell or dissolve in aromatic compounds, chlorinated hydrocarbons, ether, esters and ketones. Please see Appendix 2 for reference data. Marlon sheets do not contain hazardous substances such as:

- Lead
- Mercury
- Cadmium
- Hexavalent chromium
- Polybrominated biphenyls (PBB)
- Polybrominated diphenyl ethers (PBDE)
- Formaldehyde
- Any CFC's
- Asbestos
- Any plasticisers

For most up to date information contact Technical Service Department.

Important Notes

Environmental Policy
Brett Martin Limited is committed to ensuring that high standards of environmental performance are maintained at all the Company's sites. The Company will continue to operate in such a way as to reduce any adverse effects on the environment arising from our activities to a minimum and to consider the environment and the well-being of future generations in all Company policy decisions.

Responsibility of the End User
The information contained in this publication is based on current knowledge and is in our opinion reliable. However the accuracy of this information cannot be guaranteed for every application and for the results arising from their use.

The user/processor is always responsible for ensuring that the materials and processes are appropriate, cost effective and suitable for the intended purpose and location and they comply with laws and regulations. Technical knowledge and skills as customary in trade and industry, a normally developed capacity to make judgements as well as knowledge and observance of the applicable regulations appertaining to work, safety and hygiene are assumed.

Appendices

Appendix 1. Thermal Expansion Calculation

Example 1

A Marlon sheet is to be used to form a sign panel on the outside of a building. It is expected that the panel temperature will be as low as -12°C in winter and as high as 31°C in summer. The panel measures 1.2m wide and 1.5m high in a workshop at a temperature of 18°C. The panel is to be hung from its top edge with a fixed point at the centre, so that thermal movement takes place from the top down and from the centre horizontally to each side. Estimate the clearance required in retaining channels which will frame the bottom and sides of the sheet.

1. Width
Dimension change in cooling from 18°C to -12°C
Temperature change = 30°C
Initial width = 1.2m
Expansion coefficient = 0.068mm/m°C
Reduction in width = 1.2 x 30 x 0.068 = 2.45mm
Dimension change in heating from 18°C to 31°C
Temperature change = 13°C
Initial width = 1.2m
Expansion coefficient = 0.068mm/m°C
Increase in width = 1.2 x 13 x 0.068 = 1.06mm
Total width change = w = 2.45 + 1.06 = 3.51mm, 4mm when rounded up to the nearest mm.
As the sheet is fixed at its centre it will move half of this distance each side of the fixed point, i.e. 2mm clearance is required in each side channel.

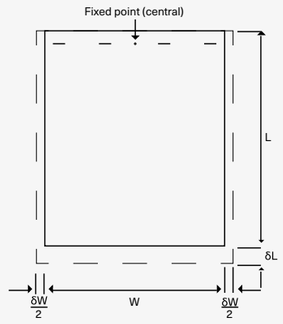
2. Length
Dimension change in cooling from 18°C to -12°C
Temperature change = 30°C
Initial length = 1.5m
Expansion coefficient = 0.068mm/m°C
Reduction in length = 1.5 x 30 x 0.068 = 3.06mm
Dimension change in heating from 18°C to 31°C
Temperature change = 13°C
Initial length = 1.5m
Expansion coefficient = 0.068mm/m°C
Increase in length = 1.5 x 13 x 0.068 = 1.33mm
Total length change = L = 3.06 + 1.33 = 4.39mm, 5mm when rounded up to the nearest mm.
As the sheet is fixed at the top it will move vertically 5mm, i.e. 5mm clearance is required in bottom channel.

Example 2

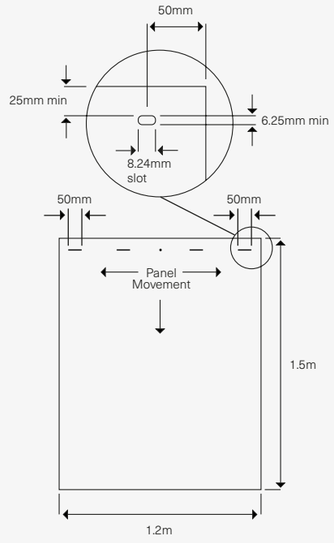
The Marlon sheet in the previous example is to be fixed with a row of screws along its top edge, with outer screws 50mm in from sheet sides. Estimate the size of slot required to accommodate thermal movement. Using screws that have a shank diameter of 6mm, the example below demonstrates how to calculate the required slot size to accommodate thermal movement.

Sheet width 1.2m
Outer slot separation =1.2 - (2 x 0.05) = 1.1m
Distance from fixed point to slot centre = 0.55m
This distance contracts as sheet cools from 18°C to -12°C by an amount 0.55 x 30 x 0.068 = 1.12mm
This distance expands as sheet heats up from 18°C to 31°C by an amount 0.55 x 13 x 0.068 = 0.49mm
The fixing must be centred in a slot with a length which can accommodate, at least, the greater amount of thermal movement. In this case, the greater movement is 1.12mm from cooling.
Minimum slot length = fixing shank diameter + (2 x greater thermal movement)
= 6 + (2 x 1.12) = 8.24mm

Example 1



Example 2



Appendix 2. Chemical Resistance

Good - little or no reduction in physical properties
Fair - some reduction in physical properties after long exposure
Poor – significant change in physical properties after short exposure
n.d. not determined
Note: Values are only indications and should not be interpreted as absolute proof of resistance of any part against a certain substance. Testing under actual exposure conditions will provide a better indication of performance.

	Concentration	Room Temperature 23ºC	Elevated Temperature 73ºC
Acids			
Acetic (CH_3COOH)	Up to 50% 70%	good poor	poor poor
Benzoic (C_6H_5COOH)	10%	fair/poor	poor
Borium (H_3BO_3)	n.d.	good	n.d.
Chromic (CrO_3)	20% 50%	good fair	n.d. n.d.
Citric $(HOOC)_3(CH_2)_2COH$	10%	good	n.d.
Formic (HCOOH)	40% 70% 97%	good fair poor	poor poor poor
Hydrochloric (HCl)	10% 20% 30%	good fair poor	n.d n.d n.d
Hydrogen fluoride (HF)	conc.	good/fair	n.d.
Lactic ($CH_3CHOHCOOH$)	85%	good	fair/poor
Nitric (HNO_3)	10% 50% 70%	good fair/poor poor	good poor poor
Oleic	-	good	n.d.
Orthophosphoric (H_3PO_4)	10% 100%	good good	fair good
Oxalic ($HOOCCOOH_2H2O$)	10% 30%	good poor	n.d. poor
Picric	2%	fair	n.d.
Phosphoric	85%	good	good
Sulphuric (H_2SO_4)	70% 90%	good fair	good
Alcohols			
Allyl alcohol CH_2=$CHCH_2OH$)	-	fair	n.d.
Amyl alcohol $(CH_3(CH_2)_3CH_2OH)$	_	good	fair
Benzyl alcohol $(C_6H_5CH_2OH)$	_	poor	n.d.
Butyl alcohol $(CH_3(CH_2)_3OH)$	_	good	good
Iso-octyl alcohol	_	fair	n.d.
Isopropyl alcohol $(CH_3CHOHCH_3)$	_	fair	fair
Phenyl-ethyl alcohol	_	poor	n.d.
Propargyl alcohol	_	good	n.d.
Dowanol PM	_	poor	n.d.
Ethanol (C_6H_5OH)	90% 100%	good poor	good poor
2-amino-ethanol (H2NC2H4OH)	_	n.d.	poor

	Concentration	Room Temperature 23ºC	Elevated Temperature 73ºC
Alcohols (continued)			
Methanol (CH_3OH)	_	poor	poor
Cyclohexanol ($C_6H_{11}OH$)	_	fair	fair
Glycerine ($HOCH_2HOCHCH_2OH$)	_	fair	n.d.
(di) Ethylene glycol $O(CH_2CH_2OH)_2$	_	good	good
Butylene glycol	_	good	n.d.
Alkalis			
Ammonium hydroxide (NH_4OH)	5% 30%	fair (crazing) poor	n.d. poor
Potassium hydroxide (KOH)	1% conc.	fair (crazing) poor	n.d. poor
Sodium carbonate (Na_2CO_3)	15%	good	fair
Sodium hydroxide (NaOH)	1% conc.	fair (crazing) poor	n.d. poor
Salts			
Ammonium fluoride (NH_4F)	sat.	poor	poor
Ammonium chloride (NH_4Cl)	10%	good	n.d.
Ammonium sulphate ($(NH_4)_2SO_4$)	10%	good	good
Ammonium sulphite ($(NH_4)_2SO_3$)	10%	poor	n.d.
Ammonium nitrate (NH_4NO_3)	10%	n.d.	good
Aluminium chloride ($AlCl_3$)	sat.	good	poor
Aluminium oxalate		good	n.d.
Aluminium sulphate ($Al_2(SO_4)_3$)	10%	good	good
Barium chloride ($BaCl_2$)	10%	good	good
Barium bromide ($BaBr_2$)	10%	n.d.	fair
Calcium chloride ($CaCl_2$)	10%	good	good
Calcium nitrate ($Ca(NO_3)_2$)	10%	good	good
Calcium hypochlorite ($Ca(Ocl)_2$)		good	n.d.
Copper chloride ($CuCl_2$)	sat.	good	n.d.
Copper sulphate ($CuSO_4$)	sat.	good	n.d.
Iron chloride ($FeCl_3$)	sat.	good	good
Iron sulphate ($FeSO_4$)	10%	good	n.d.
Magnesium chloride ($MgCl_2$)	10%	good	good
Magnesium sulphate ($MgSO_4$)	sat.	good	n.d.
Nickel/Zinc sulphate ($NiSO_4/ZnSO_4$)	sat.	good	n.d.
Potassium bromide (KBr)	sat.	good	n.d.
Potassium carbonate (K_2CO_3)	sat.	good	n.d.
Potassium cynite (KCN)		poor	n.d.
Potassium chloride (KCl)	sat.	good	n.d.
Potassium chromate (K_2CrO_4)	sat.	good	n.d.
Potassium manganate ($KMnO_4$)	10%	good	good
Potassium nitrate (KNO_3)	sat.	good	n.d.
Potassium sulphate (K_2SO_4)	sat.	good	n.d.
Sodium chloride (NaCl)	10%	good	good
Sodium chlorate ($NaClO_3$)	10%	good	n.d.
Sodium chromate ($Na_2Cr_2O_7$)	10%	good	good
Sodium carbonate (Na_2CO_3)	10%	good	n.d.
Sodium nitrate ($NaNO_3$)	10%	poor	n.d.
Sodium sulphide (Na_2S)	10%	good	good
Sodium sulphate (Na_2SO_4)	10%	good	good

	Concentration	Room Temperature 23ºC	Elevated Temperature 73ºC
Food Stuffs			
Fruit & vegetable juice	Normal use	good	good
Beer, cognac, whisky, gin, vodka, wine, rum	Normal use	good	n.d.
Milk, coffee, chocolate	Normal use	good	good
Black tea	Normal use	n.d.	fair/poor
Mineral water	Normal use	good	good
Butter, margarine, sauces & vinegar	Normal use	good	good/fair
Cooking oils	Normal use	good	good
Vegetables	Normal use	good	good
All spices except: Nutmeg, Clove oil	Normal use	good poor poor	good n.d. n.d.
Salt, sugar	Normal use	good	n.d.
Tobacco	Normal use	good	good
Ketchup, tomato puree	Normal use	good	n.d.
Fish, meat	Normal use	good	good
Oils			
Mobil 10 W 40	Normal use	good	n.d.
Skydrol 500 A	Normal use	poor	n.d.
Jet fuel JP-4	Normal use	fair	n.d.
Drill Oil Brake Fluid (ATE)	Normal use	poor	n.d. n.d.
Diesel oil Terpene oil Gasoline Super Test Gasoline Refined oil Gasoline normal	Normal use	fair fair poor poor good poor	n.d. n.d. n.d. n.d. n.d. n.d.
Soy bean oil, peanut oil, castor oil	Normal use	fair/good	n.d.
Spindle oil, dynamo oil, turbine oil, machine oil Refrigerator oil Cylinder oil Cable insulation oil Other lubricant oils	Normal use	fair fair good good good good	n.d. n.d. n.d. n.d. n.d. n.d.
Silicon oil	Normal use	good	poor
Whale grease, soap grease, lubrication greases	Normal use	good	n.d.
Molikote paste or powder	Normal use	good	n.d.
Camhor oil	Normal use	good	fair
Vaseline	Normal use	good	n.d.
Fish oil	Normal use	good	n.d.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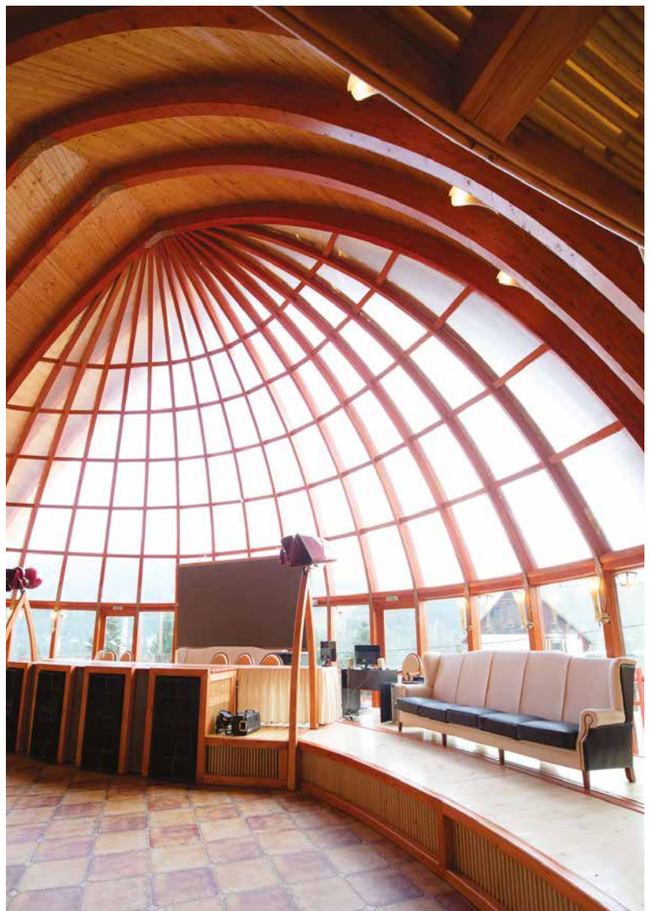

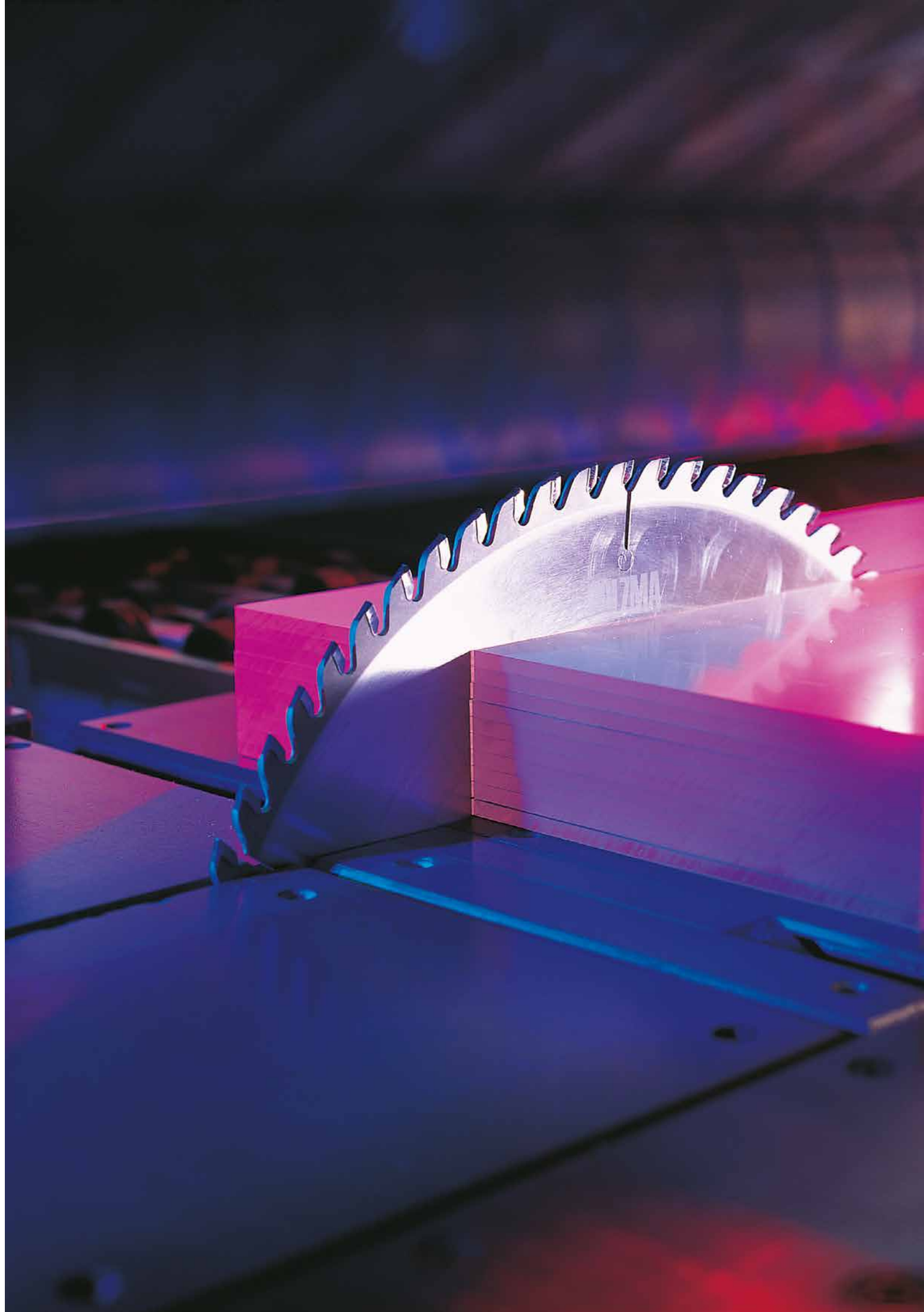

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