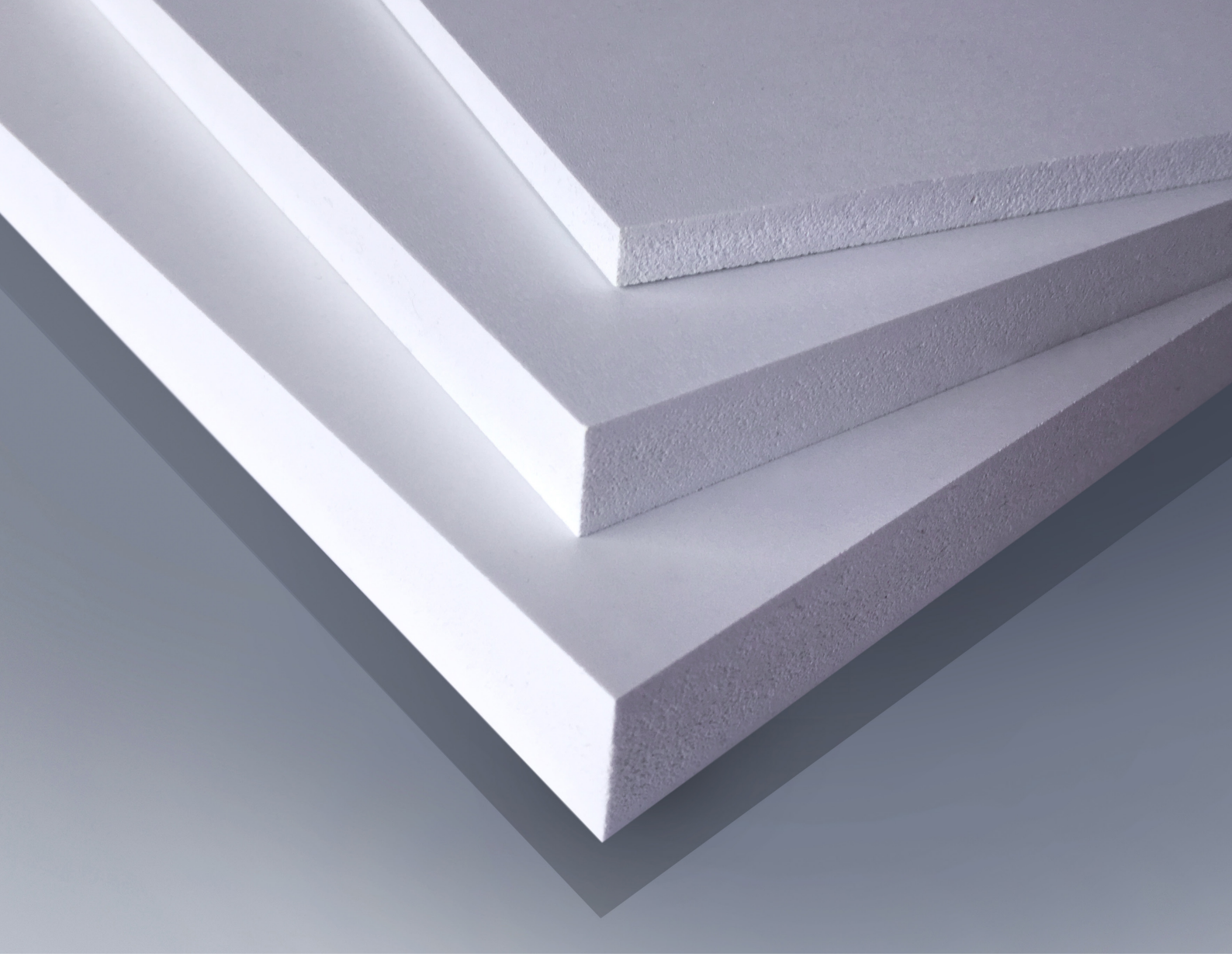


Technical Guide

# Foamalux
# Calibre

Brett Martin

# Products that work

Brett Martin is a privately owned world class industry leader and manufacturer of specialist plastic products for the construction, fabrication, signage 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 Foamalux Calibre calibrated foam PVC sheet range. 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 Foamalux Calibre 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



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# **Foamalux**
# Calibre

Foamalux Calibre combines an exceptionally light weight core with a hard flat surface. It is a superb all round calibrated PVC board which provides a cost effective alternative to traditional wood based construction materials.

Manufactured using modern plastic technology it offers dimensional stability, will not rot, mould or corrode and has a high insulation value. Calibre has endless applications in building, shop outfitting, and signage due to its smooth finish and easy workability.

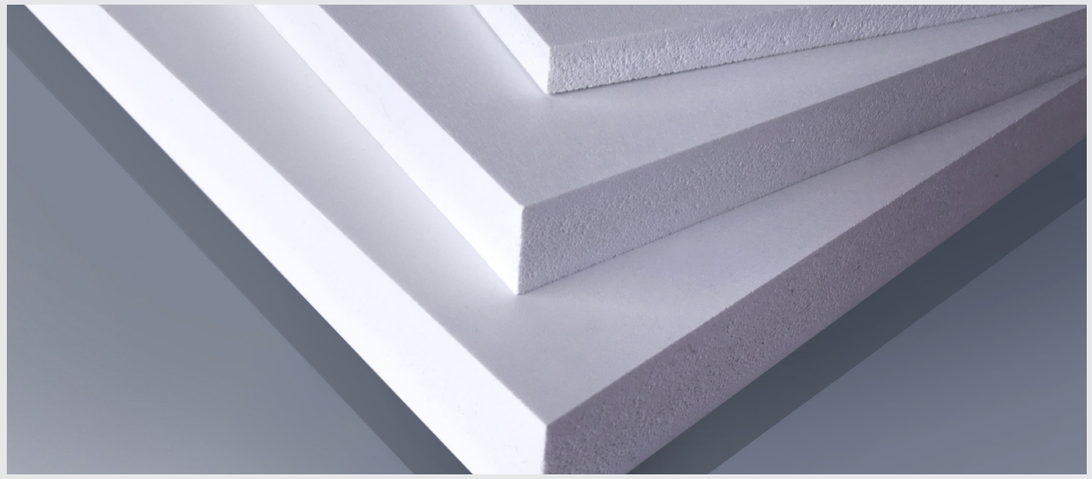
Foamalux Calibre PVC foam, as with all Brett Martin products, is manufactured to the highest standards of excellence which have earned Brett Martin BSI Registered status under BS EN ISO 9001. Production controls and specified tolerances ensure uniformity of surface finish, thickness, colour, cell structure and density across the Calibre range and tight tolerances on all these parameters.

## Quality

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

Foamalux Calibre and associated packaging are compliant with REACH Directive EC 1907/2006.

Calibre products do not contain any of the six substances covered by RoHS (Restriction of use of Hazardous Substances in Electrical and Electronic Equipment: Directive 2011/65/EC).







# Application Areas

## Design Versatility

Foamalux Calibre is a multi-purpose building board and sign and display material. It is easily processed and can be transformed in a variety of different ways to create endless fabrication possibilities.

Applications such as:

| Building | Shop Outfitting | Vehicle Fitting | Display |
|---|---|---|---|
| Window Frames and Trims | Shelving | Cladding | Large Letters |
| Fascia and Soffit Boards | Cabinetry | Lining | POS/POP Displays |
| Shutter Boxes | Display Units | Shelving | Exhibition Stand Construction |
| Partitions | Temporary Partitions | Drawers | Vinyl Application and Lamination |
| Cladding | | | |
| Wall and Ceiling Lining | | | |
| Site Hoardings | | | |



## Product Features

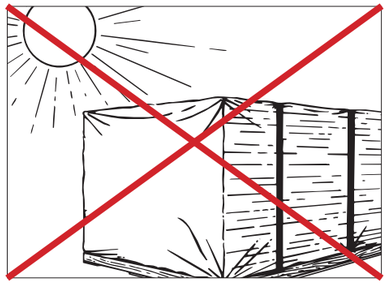
- Premium silky smooth hard surface
- Extremely lightweight and easy to handle
- Strong durable rigid board
- Moisture and mould resistant
- Insect and pest resistant
- Dimensional stability
- Chemically-resistant and non-corroding
- Low thermal conductivity
- High insulation value

# Storage & Disposal

## Surface Protection

All Foamalux Calibre sheets are covered by a protective polyethylene film. This surface protection is applied to one side of the sheet only and can be removed easily.

All Calibre 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 process to ensure the quality of finished items.



## Storage

Calibre sheets are best stored indoors, away from direct sunlight, in a cool dry store under ambient conditions.

Calibre sheets should be stacked horizontally, preferably on a continuous non-abrasive, flat, dry surface, for example, a solid topped pallet or wooden sheet raised from the floor or ground. Under the total weight of sheet loaded on to it, this support must not distort, or distortion of the sheet could occur during longer storage periods.

If stacking sheets, stack heights should not exceed 1m. Sheets of differing length should not be placed on the same stack and standing sheets on ends or sides, even for short periods should be avoided. Pallets should be stacked no more than three high.

Always store indoors where possible, 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 and the stack should be ventilated to avoid heat build-up.

Excessive temperatures during transport and storage can cause the protective film to become firmly adhered to the surface making it difficult to remove. It is recommended that the original packaging is kept in place during storage and after the pallet has been opened.

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

## Handling

Appropriate personal protective equipment should be worn when handling sheets as edges can be sharp and large/thick sheets are heavy. Calibre is a relatively flexible material but, if lifted or carried incorrectly, sheets can be stressed beyond their flexible limits and cracked.

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.

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

Foamalux Calibre is a rigid foam PVC sheet extruded from polyvinyl chloride. All products are compliant with both EU and UK REACH legislations in their current forms, and with the latest RoHS directive.

No special protective measures are needed when transporting or handling the material. When working with the material care must be taken to protect eyes and avoid inhalation of dust. Calibre sheets do not constitute fire, explosion or toxic hazard material. In case of a fire involving Calibre or any other PVC material, water, foam and carbon dioxide extinguishers may be used.

Burning causes noxious fumes to be released e.g. hydrochloric acid, carbon monoxide. Do not breathe decomposition products. When decomposition products have been accidentally inhaled, medical assistance is required.

Please contact the Brett Martin Technical Department for full PSDS (Product Safety Datasheet). 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.

Calibre 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
- Plasticisers
- Silicon

For most up to date information contact the Brett Martin Technical Service Department.

## Disposal/Recycling

**Recycling**
At the end of its product life cycle Calibre is 100% recyclable and reusable if separated from other materials. 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. Calibre Foam PVC according to industry standards falls within the remit of Category 3.




**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 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 Foamalux Calibre 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**
Foamalux Calibre should not be incinerated unless done professionally. Smouldering and incomplete combustion may cause toxic fumes and soot particles.

# Fabrication

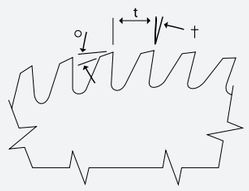
Foamalux Calibre is an easy material to work with, using basic wood and metal working tools. When working with any power tool, the sheet temperatures must be kept below the material softening point of 70°C. PVC is a thermoplastic and excessive heat build-up can result in deformation, softening and surface 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 helps lower temperatures. These measures assist in obtaining a good quality cut finish. 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 experimenting may be required to obtain best results. It is necessary to have an effective means of removing dust produced by machining operations from the operator's environment.

## Sawing

Blades designed for cutting plastics are ideal for cutting Calibre, 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, can produce an unsatisfactory finish.

When using power saws, clear swarf and avoid heat build-up at the cut to produce clean cuts. A good quality cut can be obtained using both band and circular saws. See right for guidelines of pitch, clearance angle and feed speed.




| | |
|---|---|
| Angle (°) | 10° - 15° circular saw<br>30° - 40° band saw |
| Relief angle (†) | 0°- 8° |
| Tooth pitch (t) | 5-15mm circular saw<br>2-8mm band saw |
| Circumference Speed | 1000-3000m/min |
| Feed Speed | 6-30m/min |

## Drilling

The required sheet thickness and hole diameter determine the appropriate drill type. Slower feed speeds are used in deeper holes to minimize heat build-up. Do not use liquid cooling to prevent overheating. When drilling deep holes it is recommended to regularly withdraw the drill bit.

Standard twist bits for metal are suitable for holes up to 12mm diameter in all thicknesses; good results can be obtained with a point of between 80-110° and helix angle of 10-30°. Holes over 12mm in diameter can be drilled with flat bits, normally used for drilling wood. Above 25mm diameter it is necessary to use hole saws or circular cutters.

| Parameter | Value |
|---|---|
| Tip Angle (°) | 100 – 110° |
| Helix angle (†) | 30° |
| Drill speed | 1000 - 3000 rpm |
| Feed speed | 0.2 - 0.5mm/rev. |

| Hole Size | Recommended drill type |
|---|---|
| <12mm | Standard twist bits |
| 12 – 25mm | Flat bits, used for drilling wood |
| >25mm | Hole saws or circular cutters |

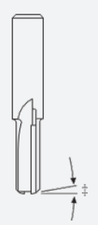


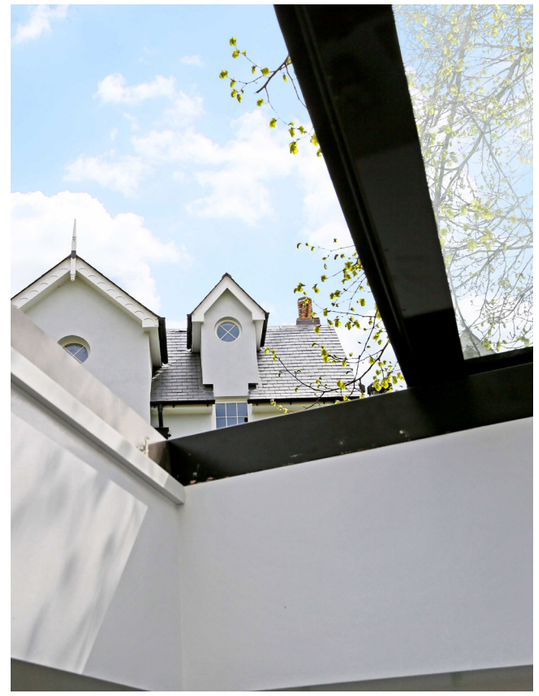

## Milling & Routing (CNC)

All types of milling machines and routers can be used to machine Calibre if suitable tool geometry and cutting conditions are used. Vacuum clamping machines are ideal as they are less likely to mark the surface than mechanical clamping. Where sheets are mechanically clamped, load spreading pads should be used to avoid surface marks. Depth milling will remove the smooth surface to reveal a matt closed cell structure.

Cutting tools must be capable of clearing large quantities of chips and cut depths and feed speeds must not be too high to avoid heat build-up and poor edge finish. Cutters with single or twin cutting edges are most suitable.

| Parameter | Value |
|---|---|
| Relief Angle (‡) | 0° - 15° |
| Cutting Speed | up to 31000rpm |
| Feed Speed | 120-325mm/s |



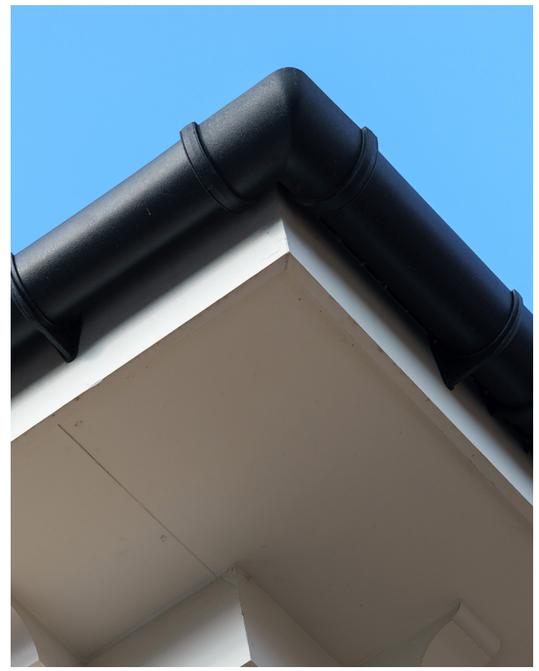
## Computer Controlled Cutting

Water-jet cutting is suitable for use in conjunction with Calibre sheets.

Laser cutting is not recommended for use in conjunction with Foamlaux Calibre PVC sheets due to the excessive heat build-up.

## 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 will expose the inner cell structure which might be undesirable in some applications. For more information on edge finishing, and decorative finishes, see page 18.



# Forming

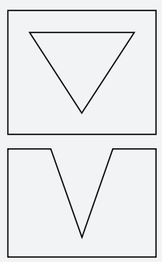
As Foamalux Calibre is a cellular material, it is not suitable for forming operations which involve excessive stretching in the elastic state. When applying localized heating, care should be taken to avoid overheating that could cause permanent deformation or material degradation. Excessive temperatures and the application of pressure may result in the rupture of the cells, blemishing and discolouration of the external surface.

**It is recommended that trials are performed before choosing any thermoforming operations to fabricate Calibre parts.**

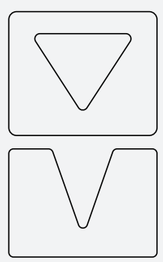
Many processing operations involve heating. Calibre is a thermoplastic material which attains an elastic state and is therefore formable at material temperatures in the range 115-135°C. The panel to be shaped or formed requires even heating throughout its area and thickness. The component formed in the elastic state, when cooled slowly to a rigid state in the forming device, retains the formed shape. Thinner sheets will be more easily thermoformed as even heating is easier to achieve.

Calibre sheets are anisotropic which means the properties of the sheet vary depending on the manufacturing direction. Like wood, which is easier to split along its grain than across its grain, Calibre sheets should always be bent across the manufacturing direction to reduce the risk of breakage.

It is essential to ensure that all panels are free from dust, oil and any other contaminants prior to any forming operation, as these will detract from the quality of the finished product.



Poor geometry - sharp corners, deep notches, thin sections



Good geometry - smooth corners, and contours, thick sections

## 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.

## Thermoforming

Air-pressure forming is possible in the thermo-elastic range at about 130°C and pressures of about 2 bars and vacuum forming at about 170°C.

It is key to heat the sheets uniformly and to monitor the temperature of the sheet. As Foamalux Calibre foam PVC has a relatively low density, heating and cooling cycles are faster than with solid thermoplastics due to the narrower processing window. Temperature controlled moulds will result in significantly better, sharper shapes, with best outcome achievable from machines which controllably heat both sides of the sheet. Prior conditioning, by suspending in an air circulating oven at about 130°C, removes inherent stresses.

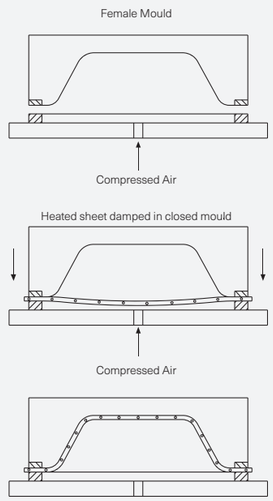
Male moulds are suitable for vacuum forming, female moulds for both vacuum and pressure forming. Secure clamping of the sheet during forming is essential to avoid shrinking; mould shrinkage (0.5 – 0.8%) Components must be completely rigid before removing from the mould. To minimize the risk of deformation always trim immediately after the formed part is removed from the mould and never place on a cold surface.

Realigning the sheet, adjustment in mound design and varying forming speeds can prevent wrinkling, webbing and bridging of the sheet.

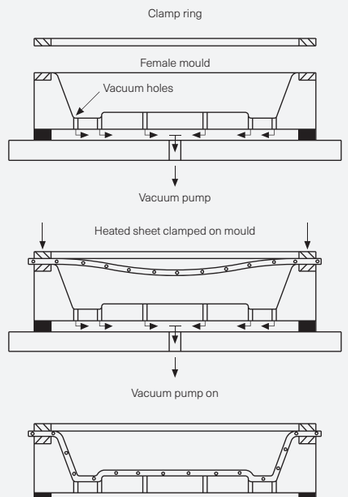
When an item involves screen printing and thermoforming for its production, the thermoforming processes should always precede the printing unless using specialised thermoformable inks.

Calibre sheets do not need to be pre-dried prior to forming.

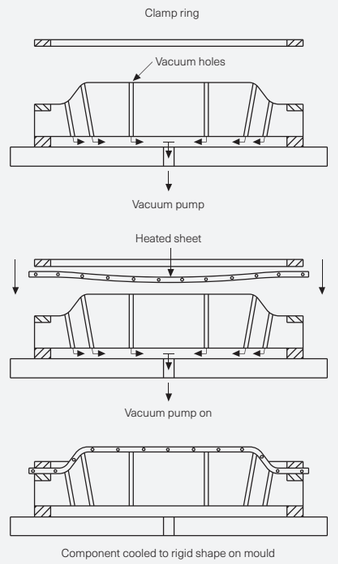
Pressure Forming in a Female Tool




Vacuum Forming in a Female Tool




Vacuum Forming in a Male Tool



# Forming

## Hot Line Bending

Care should be taken when folding due to stressing and cracking of sheets. Prior to folding, localised strip heating to about 130°C is required. Heat the material for a distance equivalent to three times the sheet thickness on each side of the fold centre line.

Heat sources such as hot air blowers, hot gas welders, hot air circulating ovens and infra-red panel heaters can be used in conjunction with Calibre products. All require controls which enable good regulation of their temperature and that of the Calibre sheet.

When heating is complete and the required shape produced, it must be allowed to cool on the forming equipment before handling or further processing, to avoid warping. Calibre can be folded on a simple jig, fitted with a forming tool having a radius of about two and a half times the sheet thickness.

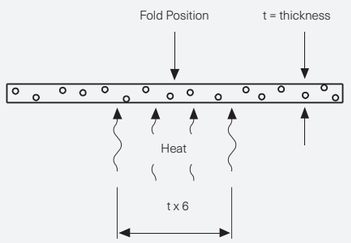
For radiant heat applications, a heating time of 20 seconds for each 1mm of sheet thickness is a reasonable starting point. For oven heating applications, this increases to 40 seconds per 1mm of sheet. Heat should be applied to both sides, reducing heating times and the possibility of surface damage.

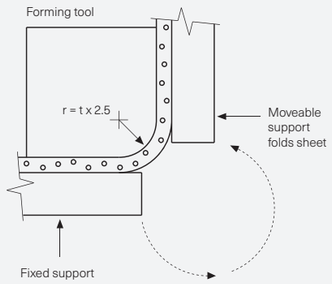
Some experimentation will always be required to obtain optimum temperatures for forming, these being a function of sheet thickness and the specific forming operation. Sheet colour and atmospheric conditions also have some influence. When using Electrical Heated Metal Tracks, the following guidelines should be adhered to:

- Maintain metal tracks at a temperature of 140-160ºC
- Sheet requires heating on both sides
- Keep heating time at approximately 50-60 seconds per mm of sheet thicknesses

Hot Air Welding Guns can be used for small areas of sheet to be folded whilst Controlled Hot Air Blowers provide localised heating used for mobile assembly work.

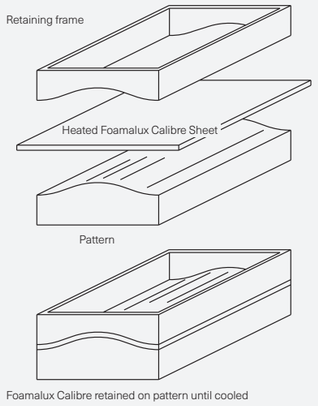
Due to its thickness, it is best practice that prior to bending Calibre sheets that any excess material at the inside of the bend is removed. This can be achieved by milling out a V groove. The outside of the bending leg can then be carefully heated, one leg raised and the seam bonded together.




## Drape Forming

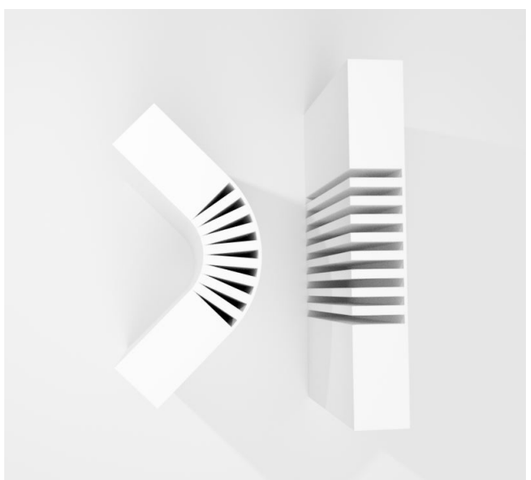
Where a specific thickness of Foamalux Calibre is to be curved to a smaller diameter than is possible by cold bending, or it is required to form a simple curved skin, it is possible to do this by softening a panel to an elastic state, draping over an appropriately shaped pattern and retaining it until cooled and rigid.



Foamalux Calibre retained on pattern until cooled

## Cold Curving

In order to cold bend sheets, parallel lines or grooves along length can be cut using a horizontal panel saw. It is best to use a pitch equal to the width of the saw blade in a sheet whilst leaving a minimum of 1 to 2mm of the material.





# Bonding

## Bonding

Foamalux Calibre can be bonded to itself or to other materials using suitable commercially available tapes and adhesives. 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 27 for cleaning recommendations) and free from oil or grease.

**The user should satisfy themselves by trial that any adhesive or bonding material will be suitable for the specific application and compatible with PVC. 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. The adhesive manufacturer's health and safety precautions must also be observed.**

## Adhesive Bonding

Foamalux Calibre can be bonded to itself and to a variety of materials such as ABS, GRP, Polycarbonate, uPVC and various woods and metals.

It is essential to use the appropriate adhesive. Never use standard PVC adhesives as they are not UV-stabilised, so joints will remain visible and may discolour when used in outdoor applications.

Double sided pressure sensitive adhesive tapes are a very efficient and effective means of attaching flat panels to each other and to support structures and of attaching other flat materials to Calibre.

See Appendix 3 for recommended adhesive suppliers.

## Bonding Calibre to Calibre

Solvent adhesives based on methyl ethyl ketone (MEK), tetrahydrofuran (THF) and cyclohexanone are suitable. Adhesives set as solvents evaporate. Therefore successful bonding requires the application of pressure and components fitted together accurately as solvent based adhesives will not fill gaps.

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.

## Bonding Calibre to Other Materials

**a)** Reaction Adhesives - There are two basic types: 1-part adhesives set by reacting with moisture; 2-part adhesives set by the reaction between a chemical base and a catalyst.

- 1-part adhesives - polyurethane or cyanoacrylate based - set very quickly and are ideal when bonding small components
- 2-part adhesives - polyester, polyurethane, polymethacrylate or epoxy based - are slower to cure, but ideal for bonding Foamalux Calibre to metals, wood and masonry

**b)** Contact Adhesives - These are used when bonding sheets of Foamalux Calibre to flat surfaces and are based on solvent solutions of synthetic rubbers - e.g. polychloroprene or nitrile rubber. Both surfaces to be joined should have adhesive applied: after solvent evaporation bring the two surfaces together under pressure.

The table on the right shows an overview of suitable adhesives per material.

| Characteristic | Contact Adhesive | 2-Part PU | Silicon Modifier Polymer | Elastic 2-part Acrylate | Adhesive Tape |
|---|---|---|---|---|---|
| Wood | √ | √ | | | |
| Chipboard | √ | √ | | | |
| Aluminium | | | √ | √ | |
| Galvanized Steel | | | √ | √ | |
| Brickwork | | √ | √ | | |
| Concrete | | √ | √ | | |
| Glass | | √ | √ | | |
| Thermoplastics | | √ | | | √ |
| Expanded Polystyrene | | √ | √ | | |
| Rubber | √ | | | | |
| Elastomers | √ | | | | |
| PVC foam | √ | | | | |
| Paper | √ | | | | |
| Cardboard | √ | | | | |
| Textiles | √ | | | | |
| Leather | √ | | | | |

Ensure adequate allowance for thermal expansion relative to ambient temperature are calculated prior to fixing. (See page 20)

# Welding

## Welding

When fabricating Foamalux Calibre sheets the same welding methods and PVC filler rods used for solid PVC welding can be used, achieving a bond strength ratio of 50-90%. Alternatively it is also possible to use thin strips of Calibre as filler rods.

As with all welding methods the sheet surface must be clean and the final bond strength depends on weld type, geometry, heating temperature and time, distribution of heat and skill level.

Hot air welding and butt welding are most commonly used in fabrication.

## Hot Plate Welding

Sheet edges are plasticised through contact, under slight pressure, 0.05 - 0.07N/mm$^2$, with a flat plate heater at a temperature of about 220°C. This is done to plasticise the sheet sufficiently for effective bonding and to induce material diffusion between the two substrates.

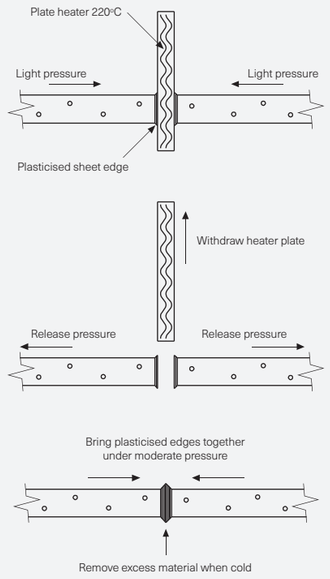
A welded joint is formed by withdrawing the tool, pressing the plasticised edges together under controlled pressure, 0.2- 0.27N/mm$^2$, and cooling.

## Hot Air Welding

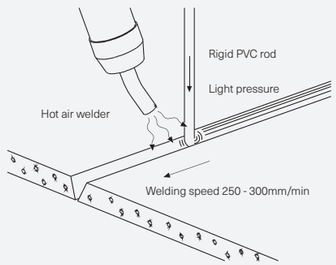
Air temperatures should be about 250°C to plasticise the sheet and welding rod sufficiently for effective bonding. Speeds of 250-300mm/min should avoid excessive heating which will damage the cell structure. Greater speed can be achieved with high speed welding nozzles. Where multiple welds of a joint are necessary, cooling between stages in fabrication is essential to avoid distortion when the component is moved.

Typical joints and the necessary panel preparations are illustrated in the diagrams.

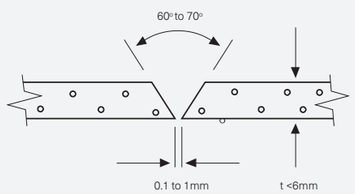
Hot Plate Welding



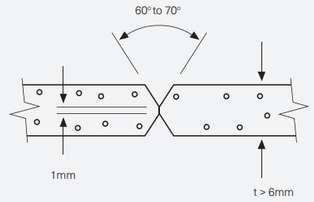

Hot Air Welding Technique



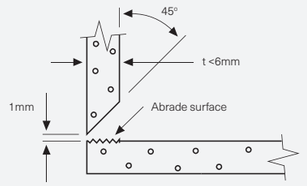

Single V Butt Weld



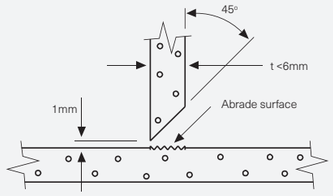

Double V Butt Weld



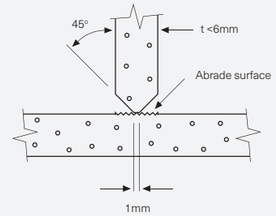

Single Bevel Corner Weld




Single Bevel Butt Weld




Double Bevel Butt Weld






# Finishing

Foamalux Calibre is a suitable substrate for a range of graphic applications creating moisture resistant, lightweight Point of Sale (POS) displays, exhibition stands and large lettering.

## Decorative Finishes

Calibre is an excellent substrate, suitable for a varied range of decorative finishing techniques. Decorative composites suitable for furniture or interior works can be created by sanding the surface of Calibre to create a roughened surface. Using a 2 part PU adhesive this can be bonded to sheet metal or synthetic resin similarly roughened.

## Edge Finishing

Creating a seamless edge which covers the visible cell structure on cut edges of Calibre can be achieved via the following methods:

- Strips of Foamalux Calibre can be bonded to the edges with an adhesive and excess material can be trimmed using a sharp cutting tool.
- Cells can be filled with putty suitable for use with PVC. Once dry this can be sanded to give a smooth finish.
- Melamine heat activated edge banding can be applied along the edges with an industrial iron. However overheating to >60° is to be avoided as this can lead to localised buckling of the sheet. Always follow the manufacturer's guidelines regarding application.

## Vinyl Graphics

Decorative and lettering/script graphics can be applied to Calibre 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.




## Painting & Varnishing

Calibre applications which require precisely matched colours can be achieved via film lamination or painting. For best results surface preparations should again be followed. Painting the surface will enhance outdoor durability as the light stabilising effect of top coats will delay UV damage and discolouration.

All application techniques - brush, roller, and spray can be used. Foamalux Calibre is most suited to paints known to have compatibility with rigid PVC. Polyurethane, Acrylic, two part Polyurethane, and Vinyl based paints are generally recommended for use with Calibre and suitable for outdoor applications. Always consult the paint manufacturer's guidelines to ensure suitability for use with Foam PVC. Water-based paints can be used but adhesion properties may not be adequate. Primers and lightly keying the surface before painting can assist with adhesion. Testing is recommended for the initial use of any coating as some paints have been known to cause embrittlement i.e. Epoxy.

When painting Calibre for use in exterior applications note that darker colours are more heat absorbent and as a result may discolour or suffer localised buckling. A paint with a higher reflectance value will help reduce heat absorption.

Drying temperature >60°C are not recommended.

## Mounting Photographs/Prints

Photo mounting to Calibre 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 for a minimum of 3hrs and avoid flexing for 24hrs.

## Adhesive Film/Vinyl

The smooth, even surface of Calibre 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

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.

# 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 Kelvin. Calibre sheets have a linear expansion coefficient of 0.068mm/mK.

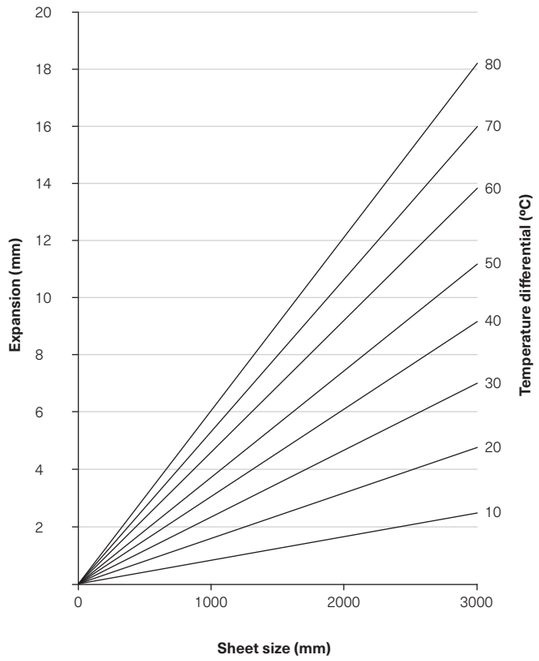
It is essential to consider the variations caused by thermal expansion when installing Calibre sheets both in indoor and short term outdoor applications. This movement must not be inhibited otherwise distortion, warping or localised buckling will occur, bearing in mind that expansion affects both the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

The service temperature range limits of Calibre are -20°C to +60°C, the overall temperature differential range of eighty degrees.

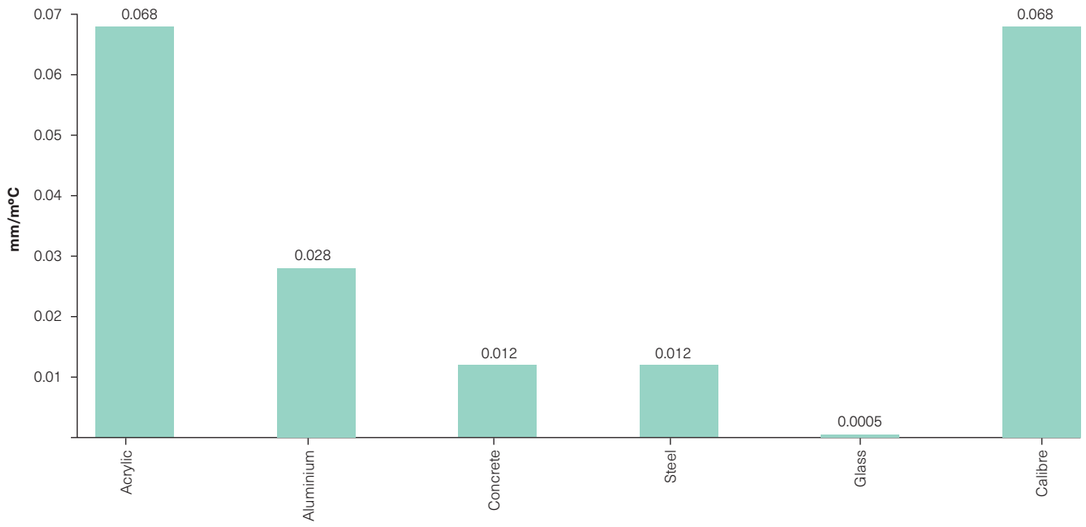
Calibre can be used in conjunction with many common building and accessory materials, the thermal expansion properties of which must also be taken into consideration. The graph on the right illustrates the relative coefficients for various materials. Calibre clearly expands much more than timber, concrete, 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 Characteristics

Thermoplastic materials have a lower thermal conductivity (K) than that of typical construction materials, giving Calibre products a higher insulation value. U-Value 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.

For thermal resistance, R ($m^2K/W$) and U-value ($W/m^2/K$) please contact Brett Martin's Technical Department.

## Low Temperatures

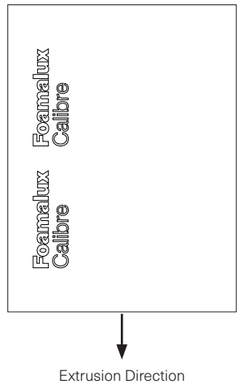
It should be noted that at lower temperatures, freezing point and below all foam PVC sheet materials become less pliable and more brittle, therefore more susceptible to damages through rough handling and impact.

Calibre should be handled with care in cold weather; all knocks and excessive twisting and bending should be avoided. When cutting, drilling or performing any other operations, care must be taken in colder conditions.

## Panel Orientation

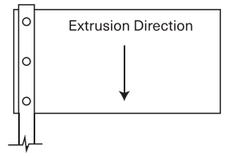
The protective film has the Calibre brand running along the direction of extrusion, providing ease of identification for correct cutting of panels for such applications.

Calibre panel with branded film

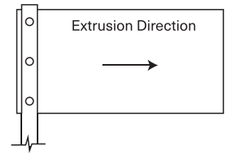



### Flexibility

Panel orientation should be considered when mounting, for example, rectangular panels mounted by only one short edge in external applications. Extruded materials generally have fractionally greater flexural strength, and therefore resistance to bending, in the direction of extrusion.




Incorrect Panel Direction

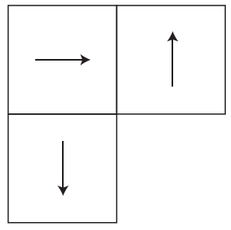



Correct Panel Direction

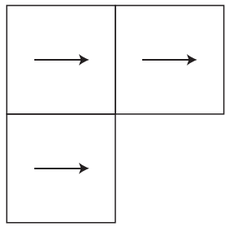
### Colour

The refractive index of a panel viewed in the extrusion direction may vary to that viewed across the extrusion direction, which could result in a slight colour difference when the panels are placed close to each other. To avoid any optical colour variations when using multiple panels, it is important to always use them in the same orientation.

Incorrect Panel Direction



Correct Panel Direction



*Arrows denote extrusion direction

# Design & Installation

## UV Stability/Exterior Signage

Outdoor applications expose the sheets to sunlight; this influences the sheet in three ways; changing the temperature, creating thermal movement; 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. It is not recommended to install PVC sheets in South-facing applications as this would be subject to maximum direct UV radiation and the exposed white or coloured sheet surface could discolour in a few weeks or months depending on the season. In North-facing, or permanently shaded situations where there is no exposure to direct sunshine colour change could be gradual over a period of years.

Covering the surface with a UV opaque ink or laminate will reduce the effect of UV in relation to surface degradation. There is virtually no degradation in internal applications, except those close to heat source applications or applications fitted close behind glass subject to sunlight, where excessive temperatures can be reached.

## Wind Loading

Any panel mounted outside a building will be subject to wind loading. Panels mounted on walls will not be critically affected by positive wind pressures which force the sheet against the wall; however, negative or suction pressures will tend to pull the sheet away from the wall.

In many external applications where panels are edge mounted in frames, they will be subject to wind pressures from both sides.

When designing an external application, wind loads should be estimated and provision made from secure means of fixing, for example, the fixing spacing should be as recommended in the Mechanical Fastening Section (See pages 25-26).

Wind loads can be calculated using EN1991-1-4.

## Precipitation

All panels in external situations will be subject to precipitation in the form of rain, sleet, snow, hail and dew. Calibre foam PVC does not absorb moisture from precipitation; therefore will not degrade or deteriorate in the presence of moisture.

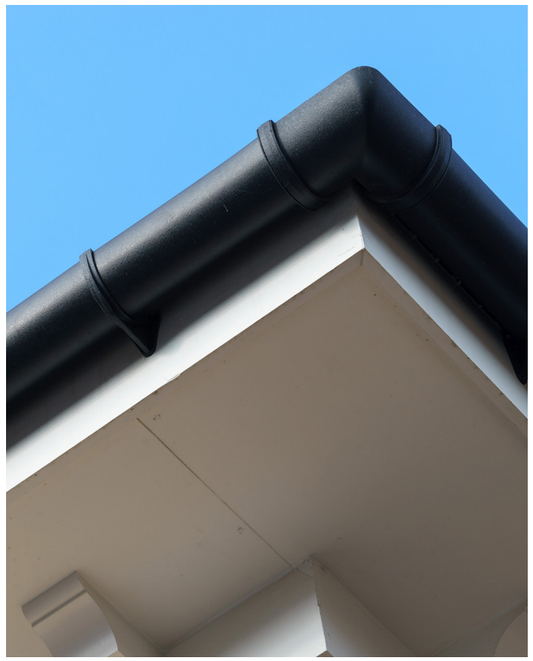
Hail storms may cause damage through impact of large hail stones on cold panels.

Internal moisture such as condensation will also not degrade Calibre.

## Sound Insulation

Foamalux Calibre has good acoustic characteristics and provides sufficient sound insulation for a lightweight material, when used in the construction of exhibition stands, wall cladding and interior partitions. Airborne noise transmission reduction provided by a single leaf partition is dependent on the mass of the material. It is the end users responsibility to ensure that material is appropriate for use.

For the Airborne Sound Reduction Indices per thickness (Rw) please contact the Brett Martin Technical Department.



## Material Properties

The properties listed are typical values obtained by testing large numbers of specimens under specified conditions and procedures. As additional processing of the sheet can influence the material properties, the information given should be treated with caution when applied to finished products.

| Characteristic | Calibre | Units | Standard |
|---|---|---|---|
| **Base polymer** | Polyvinyl Chloride (PVC) | | |
| **Form** | Unplasticised rigid foam PVC sheet | | |
| **Smell** | Odourless | | |
| **Water solubility** | Insoluble | | |
| **Service Temperature** | -20 to +60°C | | |
| **Shore Hardness** | >40 | | ISO 868 |
| **Density** | 0.5 | g/cm$^3$ | ISO 11183 |
| **Moisture absorption after 24hrs @ 23°C** | <2 | % by weight | ISO 62 |
| **Screw Pull** | 65 | N/mm | ASTM D1761-20 |
| **Oxygen index** | 49 | % | |
| **Thermal expansion Coefficient** | 0.068 | mm/m°C | ISO 11359-2 |
| **Vicat Softening Temperature** | >70 | °C | ISO 75-2 |
| **Thermal decomposition temperature** | >200 | °C | |
| **Thermal conductivity K** | 0.085 | W/m.K | ISO 22007 |

Product Liability Clause: Properties reported here are typical values, derived from in-house testing and are not intended for specification purposes. Brett Martin makes no claim that the material in any particular shipment will conform exactly to the values given. Each user of the material should test to determine the material is suitable for their end use. All information and technical advice is given in good faith, without warranty or guarantee and is subject to change without notice. Our advice does not release you from the obligation to verify the information currently provided – especially that which is contained in our safety data and technical information sheets.

# Design & Installation

## Food Contact

Foamalux Calibre is a rigid, closed cell foam, unplasticised PVC sheet.

The non-porous PVC finish on Foamalux Calibre does not absorb or harbour any microbial material and can be wiped completely clean. The closed cell structure means that the material will not absorb moisture and will not degrade or deteriorate in the presence of moisture.

Foamalux Calibre has resistance to dilute acids and alkalis, will not corrode or rot and is not prone to attack by pests. Non-abrasive domestic cleaning solutions are suitable for cleaning.

It can be used in a variety of applications in food preparation areas as wall cladding and signage for example.

Foamalux Calibre is not suitable for use in food container/packaging applications or other types of application where it is in continuous direct contact with food.

## Fire Rating

Foamalux Calibre is a self-extinguishing material and complies with most European fire test standards. Fire grade sheet available. Contact the technical department for the most up to date certification.

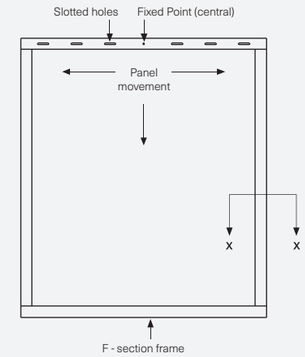
## Structures & Frames

Structures and frames commonly made from wood/ metal must accommodate the difference in thermal expansion of Foamalux Calibre, for example, when calculating sizes for fixing holes adequate allowance for unrestricted movement is essential particularly when using Calibre for cladding applications. Where possible Calibre should be mounted in a frame where it can freely expand and contract with temperature change. In a relatively temperature stable environment Calibre panels can be mounted using double sided tapes or adhesive (see adhesive section). Point fixing of Calibre is possible but allowance must be made for thermal expansion. An illustration of a typical calculation is given in Appendix 1.

Fixings should be placed at centres not exceeding those recommended in Fixings section.

Large panels mounted on external walls should be spaced from the wall surface using battens to maintain a ventilating air gap of about 20mm behind the panel. Direct mounting of the panels to the walls could result in distortion due to heat build-up.

Top Mounted Panel






## Point Fixings

Where possible Calibre should be mounted in a frame where it can freely expand and contract with temperature change. However Calibre sheets can be point fixed to supporting structures using the following recommendations. Screws are most suitable as they are most controllable: tightening a screw and then backing it off slightly allows the panel to move with temperature changes without deformation.

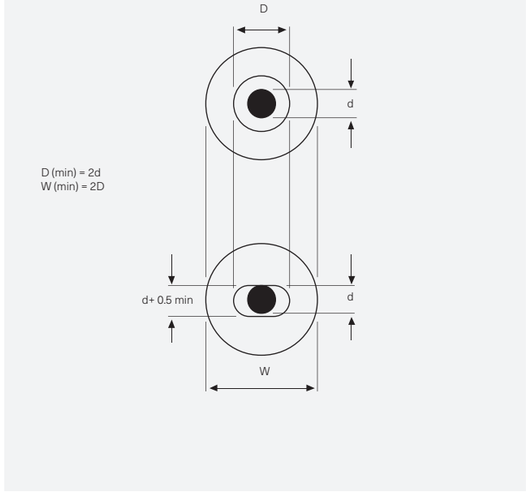
### Hole, Slot & Washer Sizes

In all cases holes must be predrilled oversize through the panel to accommodate thermal movement. This in turn necessitates the use of an oversize washer on the fastener to provide adequate retention of the sheet and spread the load.

Countersunk fixings should be avoided where possible as they will restrict thermal movement. The table below gives an example of appropriate hole, or slot and washer size for given sheet dimensions and fixing shank diameters.

For example a 1200mm sheet should have a 6mm fixing shank diameter, minimum hole diameter of 12mm and a minimum washer size of 24mm.

A full example of appropriate hole, slot and washer size for given sheet dimensions can be found in Appendix 1.



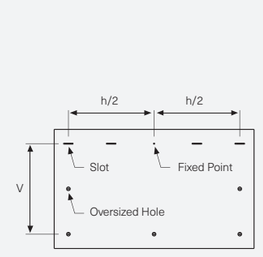

| | d = 4 | | d = 5 | | d = 6 | | d = 8 | | d = 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| V or H | D | W | D | W | D | W | D | W | D | W |
| 200 | 5 | 10 | 6 | 12 | 7 | 14 | 9 | 18 | 11 | 22 |
| 400 | 6 | 12 | 7 | 14 | 8 | 16 | 10 | 20 | 12 | 24 |
| 600 | 7 | 14 | 8 | 16 | 9 | 18 | 11 | 22 | 13 | 26 |
| 800 | 8 | 16 | 9 | 18 | 10 | 20 | 12 | 24 | 14 | 28 |
| 1000 | 9 | 18 | 10 | 20 | 11 | 22 | 13 | 26 | 15 | 30 |
| 1200 | 10 | 20 | 11 | 22 | 12 | 24 | 14 | 28 | 16 | 32 |
| 1400 | 11 | 22 | 12 | 24 | 13 | 26 | 15 | 30 | 17 | 34 |
| 1600 | 12 | 24 | 13 | 26 | 14 | 28 | 16 | 32 | 18 | 36 |
| 1800 | 12 | 24 | 13 | 26 | 14 | 28 | 16 | 32 | 18 | 36 |
| 2000 | 13 | 26 | 14 | 28 | 15 | 30 | 17 | 34 | 19 | 38 |
| 2200 | 14 | 28 | 15 | 30 | 16 | 32 | 18 | 36 | 20 | 40 |
| 2400 | 15 | 30 | 16 | 32 | 17 | 34 | 19 | 38 | 21 | 42 |
| 2600 | 16 | 32 | 17 | 34 | 18 | 36 | 20 | 40 | 22 | 44 |
| 2800 | 17 | 34 | 18 | 36 | 19 | 38 | 21 | 42 | 23 | 46 |
| 3000 | 18 | 36 | 19 | 38 | 20 | 40 | 22 | 44 | 24 | 48 |

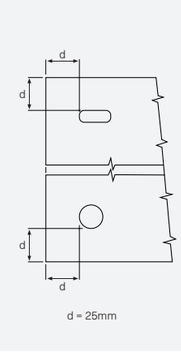
d = fixing shank diameter
D = minimum hole diameter or slot width
W = minimum washer diameter
V = vertical panel dimension
H = horizontal panel dimension

Holes or slots in a panel to accommodate fasteners should always be at least 25mm from the panel edge.

As Calibre sheet can be subject to thermal expansion and contraction in all directions, it's essential to drill circular locating holes in the center of the edges and oblong holes to the left and right of the centre.

Fixings should be spaced at 500mm.



# Design & Installation

**Screw/Staple Retention**
Small components can be mounted directly onto a Calibre sheet using screws and nails suitable for plastics. Foamalux Calibre can be used as upholstery backing boards and fabrics can be stapled directly onto the Calibre sheet surface.

Calibre foam has been tested internally according to ASTM D1761-20 and provided a screw pull value of 65N/mm using the a 6mm universal screw design.

**Screw Fixing**
To fix components onto the surface of Calibre, screws used for chipboard with a diameter of 3-4mm are best suited.

To fix external signage onto wooden or metal structures, it's recommended to use stainless steel façade screws with pre-fitted washers and rubber seals.

Always drill the hole approximately 5-6mm 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 onto the sheet.

Self-tapping screws can be used to mount lightweight items to Calibre sheets.

Countersunk fixings should be avoided where possible as they will restrict thermal movement.

**Nail/Rivet Fixings**
Nails and rivets can be used with small panels or in internal applications where there is little thermal movement since temperature differentials are small.

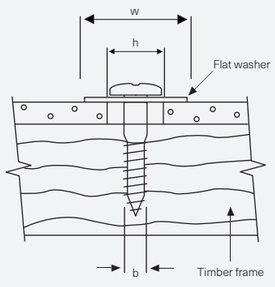
In all cases holes must be predrilled oversize through the panel to accommodate thermal movement. This in turn necessitates the use of an oversize washer on the fastener to provide adequate retention of the sheet and spread the load. Best suited are aluminium blind or pop rivets that have a stainless steel mandrel. Make sure to always position the closing head on the support structure or metal side and make the clearance holes in the sheet at least 2mm larger than the shank diameter of the rivet.

In order to avoid tension and material creeping use only pan head rivets with large heads or washers.

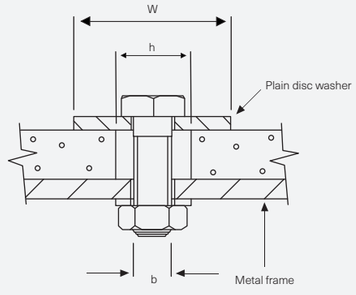
Countersunk fixings should be avoided where possible as they will restrict thermal movement.

**Bolt Fixings**
Bolts can be used to through fix Foamalux Calibre to a substructure. Clearance holes should be used to permit thermal movement. Plain washers should be used to prevent marking the surface. Do not overtighten fixings.

Wood Screw Fixing




Bolt Fixing




W = washer diameter
h = hole diameter
b = fixing shank diameter



# Cleaning & Maintenance

## Cleaning

In principle, if stored correctly the surfaces of Calibre sheets are ready for use. However, in order to ensure prime conditions for the adhesion of paints, bonding agents and adhesive films, the surfaces must be free of dust, grease, fingerprints and such before carrying out any decorative work, lamination etc.

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

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

Before any application of Calibre we recommend removing any dust on the surface by blowing with ionised air. Using 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.
- Stubborn marks can be removed with a fibrous cleaning pad, accepting a slight dulling of the surface.
- For large areas a pressure washer may be used with care.
- 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 make the material brittle, as many solvents contain a high level of aromatic components.
- Always follow manufacturer's instructions when using cleaning products.

## 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.

The base material for Foamalux Calibre is highly resistant to attack from chemicals and from pollutants in the atmosphere. Contact with solvents and wet wood preservatives must be avoided.

In short Calibre resists aqueous acids, alkalis and saline solutions as well as oils and aliphatic compounds. Sheets will swell or dissolve in aromatic compounds, chlorinated hydrocarbons, ether, esters and ketones. Please see Appendix 2 for more detailed data.

## 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 wellbeing 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 correctness 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 Foamalux Calibre 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**
Initial width = 1.2m
Dimension change in cooling from 18°C to -12°C
Temperature change = 30°C
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
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.

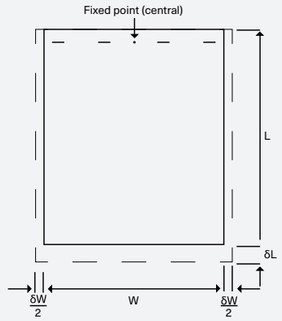
**2. Length**
Initial length = 1.5m
Dimension change in cooling from 18°C to -12°C
Temperature change = 30°C
Expansion coefficient = 0.068mm/m°C
Reduction in length = 1.5 x 30 x 0.068 = 3.06mm
Dimension change in heating from 18°C to 31°C
Temperature change = 13°C
Expansion coefficient = 0.068mm/m°C
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

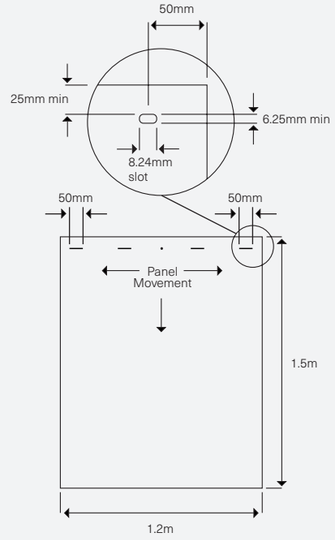
The Foamalux Calibre sheet in the previous example is to be fixed with a row of screws along its top edge, with outer screws 50mm in from sheet sides.
Estimate the size of slot required to accommodate thermal movement. Using screws that have a shank diameter of 6mm, the example below demonstrates how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

**KEY:**
**+** Good resistance
**-** Poor resistance

**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.

| Chemical Name | Resistance at 23°C | Chemical Name | Resistance at 23°C |
|---|---|---|---|
| Acetaldehyde 40% | + | Amyl chloride | - |
| Acetaldehyde 100 % | - | Aniline | - |
| Acetic acid 10% | + | Aniline chlorohydrate | - |
| Acetic acid 20% | + | Aniline hydrochloride | - |
| Acetic acid 80% | + | Anthraquinone sulphonic acid | + |
| Acetic acid, glacial | + | Antimony trichloride | + |
| Acetic anhydride | - | Aqua regia | + |
| Acetone | - | Aromatic hydrocarbons | - |
| Adipic acid | + | Arsenic acid 80% | + |
| Allyl alcohol 96% | + | Arylsulphonic acid | + |
| Allyl chloride | - | Barium carbonate | + |
| Alum | + | Barium chloride | + |
| Aluminium alum | + | Barium hydroxide | + |
| Aluminium chloride | + | Barium sulphate | + |
| Aluminium fluoride | + | Barium sulphide | + |
| Aluminium hydroxide | + | Beer | + |
| Aluminium oxychloride | + | Beer sugar liquors | + |
| Aluminium nitrate | + | Benzaldehyde 10% | + |
| Aluminium sulphate | + | Benzaldehyde, above 10% | - |
| Ammonia gas (dry) | + | Benzene | - |
| Ammonia, liquid | - | Benzine | + |
| Ammonium acetate | + | Benzoic acid | + |
| Ammonium alum | + | Bismuth carbonate | + |
| Ammonium bifluoride | + | Bleach 12% Cl | + |
| Ammonium carbonate | + | Borax | + |
| Ammonium chloride | + | Boric acid | + |
| Ammonium fluoride 25% | + | Bromic acid | + |
| Ammonium hydroxide | + | Bromine liquid | - |
| Ammonium metaphosphate | + | Bromine water | + |
| Ammonium nitrate | + | Butadiene | + |
| Ammonium persulphate | + | Butane | + |
| Ammonium phosphate | + | Butanol normal | + |
| Ammonium sulphate | + | Butanol iso | + |
| Ammonium sulphide | + | Butyl acetate | - |
| Ammonium thiocyanate | + | Butyl phenol | + |
| Amyl acetate | - | Butyric acid | + |
| Amyl alcohol | + | Cadmium cyanide | + |

| Chemical Name | Resistance at 23°C | Chemical Name | Resistance at 23°C |
|---|---|---|---|
| Calcium bisulphite | + | Diazo salts | + |
| Calcium carbonate | + | Diglycolic acid | + |
| Calcium chlorate | + | Dimethylamine | + |
| Calcium chloride | + | Dioctyl phthalate | - |
| Calcium hydroxide | + | Disodium phosphate | + |
| Calcium hypochlorite | + | Distilled water | + |
| Calcium nitrate | + | Esters | - |
| Calcium oxide | + | Ethers | - |
| Calcium sulphate | + | Ethyl acetate | - |
| Carbon disulphide | - | Ethyl acrylate | - |
| Carbon dioxide | + | Ethyl alcohol | + |
| Carbon monoxide | + | Ethyl chloride | - |
| Carbon tetrachloride | + | Ethyl ether | - |
| Carbonic acid | + | Ethylene bromide | - |
| Castor oil | + | Ethylene chlorohydrin | - |
| Caustic potash | + | Ethylene dichloride | - |
| Caustic soda | + | Ethylene glycol | + |
| Chloroacetic acid | + | Ethylene oxide | - |
| Chloral hydrate | + | Fatty acids | + |
| Choric acid 20% | + | Ferric chloride | + |
| Chlorine (dry) | - | Ferric hydroxide | + |
| Chlorine (wet) | - | Ferric nitrate | + |
| Chlorine water | + | Ferric sulphate | + |
| Chlorobenzene | - | Ferrous chloride | + |
| Chloroform | - | Fluoboric acid | + |
| Chlorosulphonic acid | + | Fluorine gas (wet) | + |
| Chrome alum | + | Fluorine gas (dry) | + |
| Chromic acid 10% | + | Fluorosillicic acid 25% | + |
| Chromic acid 50% | - | Formaldehyde | + |
| Citric acid | + | Formic acid | + |
| Copper carbonate | + | Fructose | + |
| Copper chloride | + | Fruit juices and pulp | + |
| Copper cyanide | + | Furfural | - |
| Copper fluoride | + | Gallic acid | + |
| Copper nitrate | + | Glucose | + |
| Copper sulphate | + | Glycerine | + |
| Cottonseed oil | + | Glycol | + |
| Cresol | + | Glycolic acid | + |
| Cresylic acid | - | Heptane | + |
| Crotonaldehyde | - | Hexane | + |
| Crude oil | + | Hexanol, tertiary | + |
| Cupric fluoride | + | Hydrobromic acid 20% | + |
| Cupric sulphate | + | Hydrochloric acid 10% | + |
| Cuprous chloride | + | Hydrochloric acid 35% | + |
| Cyclohexanol | - | Hydrocyanide acid | + |
| Cyclohexanone | - | Hydrofluoric acid 50% | + |
| Detergents | + | Hydrogen | + |
| Dextrin | + | Hydrogen peroxide 30% | + |
| Dextrose | + | Hydrogen peroxide 90% | + |



| Chemical Name | Resistance at 23°C | Chemical Name | Resistance at 23°C |
|---|---|---|---|
| Hydrogen phosphide | + | Nickel chloride | + |
| Hydrogen sulphide | + | Nickel nitrate | + |
| Hydroquinone | + | Nickel sulphate | + |
| Hydroxylamine sulphate | + | Nicotine | + |
| Hypochlorous acid | + | Nicotine acid | + |
| Iodine | - | Nitric acid, anhydrous | - |
| Kerosene | + | Nitric acid 10% | + |
| Ketones | - | Nitric acid 60% | + |
| Lactic acid 25% | + | Nitric acid 68% | + |
| Lauric acid | + | Nitrobenzene | - |
| Lauryl chloride | + | Nitrous oxide | + |
| Lead acetate | + | Oils and fats, vegetable | + |
| Lead chloride | + | Oleic acid | + |
| Lead sulphate | + | Oleum | - |
| Lead tetraethyl | + | Oxalic acid | + |
| Linoleic acid | + | Oxygen | + |
| Linseed oil | + | Ozone | + |
| Lithium bromide | + | Palmitic acid | + |
| Lubricating oil | + | Paraffin | + |
| Machine oil | + | Perchloric acid 10% | + |
| Magnesium carbonate | + | Perchloric acid 15% | + |
| Magnesium chloride | + | Perchloric acid 70% | + |
| Magnesium citrate | + | Petrol | + |
| Magnesium hydroxide | + | Petrol high octane | + |
| Magnesium nitrate | + | Phenol | + |
| Magnesium sulphate | + | Phenylhydrazine | - |
| Maleic acid | + | Phenylhydrazine hydrochloride | + |
| Malic acid | + | Phosgene gas | + |
| Mercuric chloride | + | Phosgene liquid | - |
| Mercuric cyanide | + | Phosphoric acid 10% | + |
| Mercurous nitrate | + | Phosphoric acid 85% | + |
| Mercury | + | Phosphoric acid (yellow) | + |
| Methyl alcohol | + | Phosphorus pentachloride | + |
| Methyl bromide | - | Phosphorus trichloride | - |
| Methyl chloride | - | Photographic solutions | + |
| Methyl methacrylate | - | Pictic acid | - |
| Methylene chloride | - | Potassium alum | + |
| Methyl ethyl ketone | - | Potassium bicarbonate | + |
| Methyl iso butyl ketone | - | Potassium bichromate | + |
| Methyl sulphate | + | Potassium borate | + |
| Methyl sulphuric acid | + | Potassium bromate | + |
| Milk | + | Potassium bromide | + |
| Mineral oils | + | Potassium carbonate | + |
| Molasses | + | Potassium chromate | + |
| Monochloracetic acid | + | Potassium chlorate | + |
| Muriatic acid | + | Potassium chloride | + |
| Naphtha | + | Potassium cyanide | + |
| Napthalene | - | Potassium dichromate | + |
| Natural gas | + | Potassium ferricyanide | + |

| Chemical Name | Resistance at 23°C | Chemical Name | Resistance at 23°C |
|---|---|---|---|
| Potassium ferrocyanide | + | Stannous chloride | + |
| Potassium fluoride | + | Starch | + |
| Potassium hydroxide | + | Stearic acid | + |
| Potassium nitrate | + | Sulphur | + |
| Potassium perborate | + | Sulphur dioxide (dry) | + |
| Potassium perchlorate | + | Sulphur dioxide (wet) | + |
| Potassium permanganate 10% | + | Sulphur trioxide | + |
| Potassium permanganate 25% | + | Sulphuric acid 3% | + |
| Potassium sulphate | + | Sulphuric acid 70% | + |
| Propane liquid | + | Sulphuric acid 80% | + |
| Propane gas | + | Sulphuric acid 85% | - |
| Propargyl alcohol | + | Sulphurous acid | + |
| Propyl alcohol | + | Tallow | + |
| Propylene dichloride | - | Tall oil | + |
| Plating solutions | + | Tannic acid | + |
| Rochelle salts | + | Tartaric acid | + |
| Sea water | + | Tetraethyl lead | + |
| Selenic acid | + | Tetrahydrofurane | - |
| Sewage | + | Thionyl chloride | - |
| Sillicic acid | + | Terpineol | + |
| Silver cyanide | + | Titanium tetrachloride | - |
| Silver nitrate | + | Tanning liquors | + |
| Silver plating solution | + | Toluene | - |
| Silver sulphate | + | Transformer oil | + |
| Soaps | + | Tributyl phosphate | - |
| Sodium acetate | + | Trichlorethylene | - |
| Sodium alum | + | Triethanolamine | + |
| Sodium benzoate | + | Trimethyl propane | + |
| Sodium bicarbonate | + | Trisodium phosphate | + |
| Sodium bisulphate | + | Turpentine | + |
| Sodium bisulphite | + | Urea | + |
| Sodium bromide | + | Urine | + |
| Sodium carbonate | + | Water - deionized | + |
| Sodium chlorate | + | Water - distilled | + |
| Sodium chloride | + | Water - demineralized | + |
| Sodium cyanide | + | Water - salt | + |
| Sodium dichromate | + | Whiskey | + |
| Sodium ferricyanide | + | Wines | + |
| Sodium ferrocyanide | + | Xylene | - |
| Sodium fluoride | + | Yeast | + |
| Sodium hydroxide 10% | + | Zinc chloride | + |
| Sodium hydroxide 50% | + | Zinc nitrate | + |
| Sodium hypochlorite | + | Zinc sulphate | + |
| Sodium nitrate | + | | |
| Sodium peroxide | + | | |
| Sodium sulphate | + | | |
| Sodium sulphide | + | | |
| Sodium sulphite | + | | |
| Stannic chloride | + | | |





## Appendix 3. Adhesives Manufactures

### Ureka Global Ltd

(Formerly Alansons Industries Ltd)
7 Flowers Hill
Brislington
Bristol
BS4 5JJ
England
Tel: 0117 971 1364
Email: sales@thenamethatsticks.com
Web: alansonsuk.com

### 3M United Kingdom plc

3M Centre Cain Road
Bracknell
Berkshire
RG12 8HT
England
Tel: 01344 858000
Fax: 01344 858278
Email: innovation.uk@mmm.com
Web: 3M.co.uk

### Stelmax Ltd

Unit 21-23 Gloster Road Martlesham Heath
Industrial Estate Ipswich
Suffolk
IP5 3RD
England
Tel: +44 (0) 1473 622265
Fax: +44 (0) 1473 610651
Email: sales@stelmax.co.uk
Web: stelmax.co.uk

### Dunlop Adhesives Ltd

Building Adhesives Limited Longton Road
Trentham
Stoke-on-Trent
ST4 8JB
England
Tel: +44 (0) 1782 591100
Fax: +44 (0) 1782 591101
Email: info@building-adhesives.com
Web: dunlop-adhesives.com

### Bostik Ltd

Ulverscroft Road Leicester
LE4 6BW
England
Tel: 01785 272727
Fax: 0116 268 9211
Email: technical.service@bostik.com
Web: bostik.co.uk

### Dow Corning Europe SA

Parc Industriel –
Zone C Rue Jules Bordet
7180 Seneffe
Belgium
Tel: +32 64 888 000
Fax: +32 64 888 401
Web: dowcorning.com




ABC

**Head Office & Global Sales**
Brett Martin Ltd
24 Roughfort Road
Newtownabbey, Co. Antrim
Northern Ireland, BT36 4RB

**t:** +44 (0) 28 9084 9999
**f:** +44 (0) 28 9083 6666
**e:** technical@brettmartin.com
commercial@brettmartin.com

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For the latest information visit
**brettmartin.com**

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