

# INSTRUCTION OPTIONS

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## INSTRUCTION OPTIONS

### 1 INTRODUCTION

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The manufacture of plastic articles from IMPEX<sup>®</sup> HC sheet normally involves secondary fabrication operations, including sawing, drilling, decorating, and assembling.

This guide covers the properties and characteristics of IMPEX<sup>®</sup> HC that need to be taken into account if secondary operations are to be performed successfully.

The protective film on IMPEX<sup>®</sup> HC sheets must not be removed during treatment or during machining to avoid scratching or damaging the surface of the panel. For thermal processing, the standard protective film must first be removed or sheets must be used with our specially developed protective film.

### 2 STORAGE AND HANDLING

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The originally packed plastic sheets should neither be stored outside nor be exposed to great variations of weather and/or temperature. When storing under conditions with substantial variation of temperature and humidity, flat shape distortion (corrugation) of the sheet can happen, even when stored flat and stacked.

Polyethylene film protects sheets against dirt, mechanical load and scratches. It is recommended to leave the protective PE film in place until final processing.

Sheets are covered with self-adhesive PE-film to have better protection during mechanical processing. Depending on the storage conditions it has to be considered that the foil could be difficult to remove and glue residues remain on the surface. Please do not store the sheets near heat sources.

The film has a restricted life-time and weathering and temperature resistance are limited. If sheet is stored inside under normal stable storage conditions, it is recommended to remove the film 6 months after film application latest.

Differences in temperature and moisture-content between top- and bottom-side of sheet or between different sheet areas can cause different dimension changes inside the sheet. This can result in waviness of the sheet after a short time. It is recommended to store the sheet under constant temperature- and humidity-conditions on a flat surface.

## INSTRUCTION OPTIONS

### 3 MATERIAL PREPARATION

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#### 3.1 Cleaning

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Protection film removal will induce a build-up of the electrostatic charge on the sheet surface. This electrostatic charge attracts airborne dust, and other fine particles.

Therefore, prior to further processing, it is recommended to clean the sheet by antistatic treatment (e.g. blowing by ionised compressed air or cleaning by hand with a cloth wetted with suitable antistatic agents).

Do not use pointed or sharp tools, they can destroy the coating.

Plain water will suffice for both cleaning and care of the sheets. In case of excessive dirt, clean with warm water and a non-abrasive cleaning agent. The sheets should be dried with a soft cloth or with chamois leather, avoid using microfiber cloths.

Very greasy and oily surfaces should be cleansed with aromatic -free benzine or petroleum ether.

Other chemicals suitable for cleaning IMPEX<sup>®</sup> HC sheets:

- Diluted acids such as citric acid, hydrochloric acid, sulphuric acid
- Common vinegar
- White spirit, neutral soap and household detergents.

After cleaning with the named chemicals, it is recommended to rinse with a mild soapy solution or water. Before cleaning with chemicals, it is recommended to carry out separate preliminary tests. Do not use alkaline cleaners

## INSTRUCTION OPTIONS

### 3.2 Dimensional Change

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There are substantial orientation forces involved in the extrusion process to form the sheet from the molten polymer. A part of these forces remains “frozen” in the sheet. During heating processes it could cause change of dimensions. Such dimensional change, called shrinkage, has to be taken into consideration when cutting sheets. The shrinkage is always higher in parallel to the extrusion direction. Longitudinal shrinkage is always higher in thin sheets and lower in thick sheets.

### 3.3 Thermal Linear Change

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Like nearly all materials, IMPEX<sup>®</sup> HC is subject to linear change at variable temperatures. Plastics show higher linear change than metals, and this must be taken into account when mounting IMPEX<sup>®</sup> HC sheets into frames.

Material	$\alpha$ [mm/m•K]
IMPEX <sup>®</sup> HC	0,065

When mounting IMPEX<sup>®</sup> HC sheets, attention must be paid to the elongation clearance in order to avoid damage during material usage. For more technical data - see chapter „6 Glazing“.

### 3.4 Dimensional Change Effected By Moisture Content

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IMPEX<sup>®</sup> HC sheets absorb moisture during storage and application. Beyond the thermal linear change, the content of moisture can effect an additional dimensional change.

When mounting IMPEX<sup>®</sup> HC sheets, attention must be paid to the elongation clearance in order to avoid damage during material usage.

Variation and differences in moisture content between interior and outside surface of a sheet (e.g. swimming-pool glazing, terrarium, greenhouse, winter garden) effect different elongation between the sheet surfaces. This difference can cause curvature of the mounted sheet.

This curvature can be avoided by choosing an applicable higher thickness of sheet, in order to get inherent stability. Preliminary tests are recommended.

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### 3.5 Flatness

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With increasing thickness IMPEX<sup>®</sup> HC sheets can show a slight deviation in flatness due to the cooling behaviour of the material.

Flatness is determined on a cut-to-size sample 1000 x 1000 mm.

Thickness	Planarity
≤ 10 mm	≤ 2mm
> 10 mm	≤ 3 mm

## INSTRUCTION OPTIONS

### 4 FABRICATING

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#### 4.1 Machining guidelines

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IMPEX<sup>®</sup> HC sheet can be worked with most tools used for machining wood or metal.

Tool speeds should be such that the sheet does not melt from frictional heat.

In general, the highest speed at which overheating of the tool or plastic does not occur will give the best results.

It is important to keep cutting tools sharp at all times. Hard, wear-resistant tools with greater cutting clearances than those used for cutting metal are suggested.

High-speed or carbon-tipped tools are efficient for long runs and provide accuracy and uniformity of finish.

Since plastics are poor heat conductors, the heat generated by machining operations will be absorbed by the tool.

A jet of air directed on the cutting edge aids in cooling the tool and in removing chips.

Coolants must be tested for chemical resistance in contact with IMPEX<sup>®</sup> HC before use.

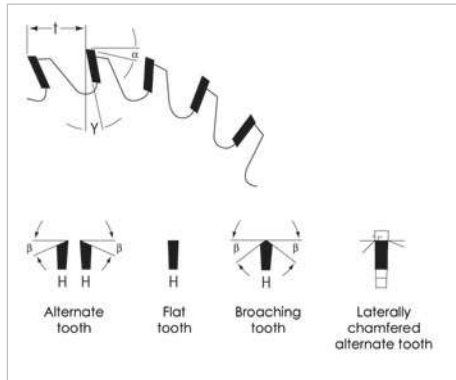
The protective film on Polycasa sheets should not be taken off during handling and machining in order to prevent scratches or damaging the surface of the sheet.

Machining of plastic materials will result in stress build-up in the material.

For applications where the treated surface is in contact with active solvents e.g. decorating and cementing, it is recommended to anneal the parts prior to this secondary step.

## INSTRUCTION OPTIONS

### 4.2 Sawing



*Figure 1  
Example of saw blades*

Many types of sawing operations can be used to cut polycarbonate sheet: band saw, circular saw and jigsaw as well as hand operated saws.

It is recommended that new or well-sharpened tools are used. At very high cutting speeds, the saw blade should be cooled with a jet of air.

The total height of a sheet stack has to be considered. A high sheet stack could lead to overheating of the edges resulting in poor sawing edges or slight welding of the sheets.

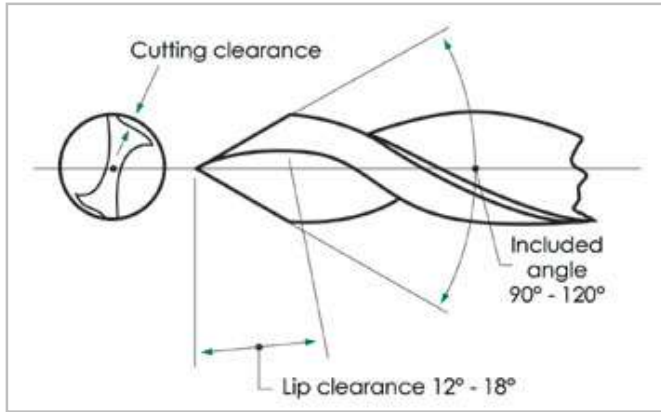
Rubbing surface of the saw blade in the product is low when the excess length of the saw blade will not exceed 5 mm above the top IMPEX<sup>®</sup> HC sheet in the stack.

#### Sawing Recommendations

Type of sawing	Band saw	Circular saw
Tooth distance	sheet thickness 2 to 12 mm, 2 to 3 mm	8 to 12 mm
Clearance angle $\alpha$	30 to 40°	15°
Rake angle $\Psi$	15°	10°
Tooth angle $\beta$	-	15°
Cutting speed	1200 - 1700 m/min	2500 - 4000 m/min
Feed speed	-	20 m/min

**INSTRUCTION OPTIONS**

4.3 Drilling



*Figure 2  
Suggested drill-point design*

Drills designed especially for plastics are available, and their use is suggested.

Standard twist drills for wood or metal can be used; however they require slower speeds and feed rates to produce a clean hole.

Twist drills for plastics should have 2 flutes, a point with an included angle of 90° to 120°, and a lip clearance of ~30°; as shown in Figure 2.

Wide, highly polished flutes are desirable since they expel the chips with low friction and thus tend to avoid overheating and consequent gumming.

Drills should be backed out often to free chips, especially when drilling deep holes.

Peripheral speeds of twist drills for IMPEX<sup>®</sup> HC ordinarily range from 10 to 61 m per minute.

The rate of drill feed into the plastic sheet generally varies from 0.10 to 0.50 mm per revolution.

NOTE: When drilling, be sure to hold or clamp the sheet securely to prevent it from cracking or slipping and presenting a safety hazard to the operator. The operator has to wear appropriate personal protective equipment.



## INSTRUCTION OPTIONS

### 4.4 Thread cutting

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Conventional 4-flute taps can be used for cutting internal threads in plastic sheet when a close fit is required. Such taps, however, have a tendency to generate considerable heat during the tapping operation.

A high-speed, 2-flute tap should offer longer life and greater tapping speed than a conventional tap, as well as provide clearance for chip discharge. Flutes should be ground so that both edges cut simultaneously; otherwise the thread will not be uniform.

Cutting edges should be 85° from the centre line, giving a negative rake of 5° on the front face of the lands so that the tap will not bind in the hole when it is backed out.

It is desirable to have some relief on the sides of threads. The pilot hole must be 0.1 mm bigger than for steel.

When tapping IMPEX<sup>®</sup> HC it is recommended that molybdenum sulphide should be used for lubrication. Cooling lubricants have to be tested before use.

### 4.5 Milling

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Sheet manufactured from IMPEX<sup>®</sup> HC can be machined with standard high-speed milling cutters for metal, provided they have sharp edges and adequate clearance at the heel.

Universal, profile, spindle moulding and hand milling cutters at cutting speeds up to 4500 m/min can be used for milling IMPEX<sup>®</sup> HC sheets. Small tool diameters require the application of one or two-edged milling cutters. They offer perfect removal of chips, high cutting speed and an excellent milling pattern.

When using one-edged milling cutters, the clamping chuck must be carefully tightened to avoid component marks on the sheet.

Cooling is not always required when milling IMPEX<sup>®</sup> HC sheets with one or two-edged end mills, as they produce less heat than multi-edged end mills.

End milling of IMPEX<sup>®</sup> HC sheets are possible with considering the following recommendations:

Diameter of the end miller	4 - 6 mm
Feed rate	ca.1.5 m/min
Rotation/min	18 - 24.000

## INSTRUCTION OPTIONS

### 5 FORMING

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#### 5.1 Hot bending

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IMPEX<sup>®</sup> HC sheets are not suitable for hot bending, the sheets may only be installed in a smooth version, any change in shape of the sheets will damage the abrasion-resistant coating.

#### 5.2 Cold bending

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IMPEX<sup>®</sup> HC sheets are not suitable for cold bending, the sheets may only be installed in a smooth version, any change in shape of the sheets will damage the abrasion-resistant coating.

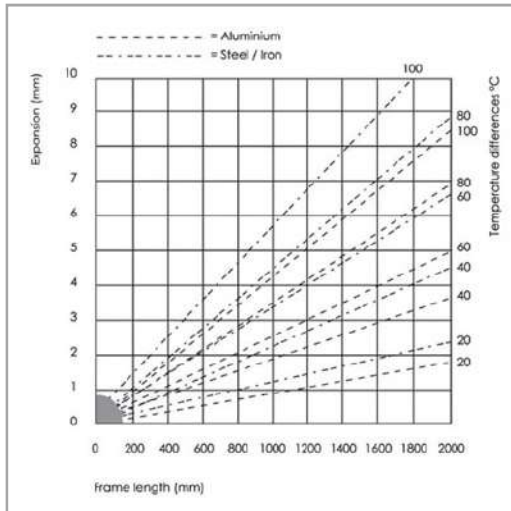
#### 5.3 Thermoforming

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IMPEX<sup>®</sup> HC sheets are not suitable for hot bending, the sheets may only be installed in a smooth version, any change in shape of the sheets will damage the abrasion-resistant coating.

## INSTRUCTION OPTIONS

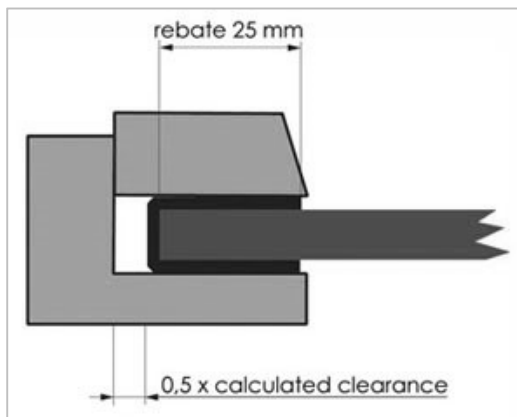
### 6 GLAZING



*Figure 3  
Graphic of the expansion of metal profiles*

IMPEX<sup>®</sup> HC sheets used in glazing applications result in considerable energy cost savings by preventing excessive heat loss in winter and by blocking heat entry in the summer.

When processing IMPEX<sup>®</sup> HC sheets with other materials, different rates of expansion on heating should be taken into consideration. IMPEX<sup>®</sup> HC is frequently used in conjunction **with metal profiles**, and care should be given to allow sufficient room for expansion and contraction.



*Figure 4  
Side view: frame with rebate and calculated clearance*

IMPEX<sup>®</sup> HC expands under heat and moisture absorption and contracts in cold and dry weather. The linear change solely due to the change in temperature can be determined by calculating the coefficient of thermal expansion.

**IMPEX<sup>®</sup> HC shows a coefficient of thermal expansion of 0.065 mm/m•°C.**

Example: A square meter PC sheet in 5mm will be mounted in an area with a temperature between 10°C and 70°C .So a change of 60 °C has to be considered. Calculation: 1,0 m x 0,065 mm/(m °C) x 60°C = 3,9 mm expansion

The linear change must be allowed during the sheet's storage time. The maximum expected value of linear deformation depends on the temperature used when mounting the sheets.

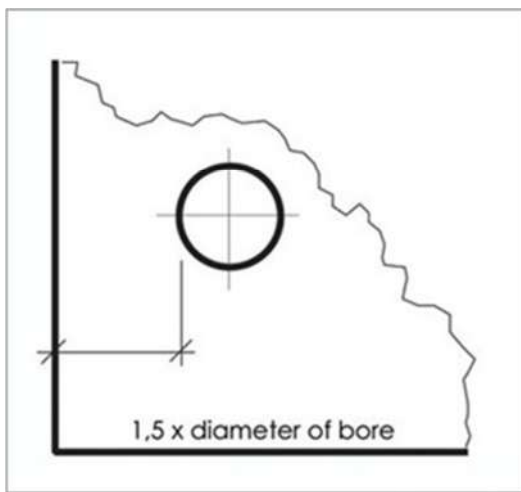
**An adequate free space of 5 mm/m should be kept with IMPEX<sup>®</sup> HC (guide value). The rebate should be approx. 20 – 25 mm deep.**

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To achieve impermeability of glazing to rain water, only sealing agents shall be used which are compatible with extruded polycarbonate sheet.

Construction and sealing material must allow the movement of sheet inside the profiles due to dimensional changes of sheet.

Profiled EPDM joints, preferably in white, have proven to be successful in heat loss avoidance. In most cases, profiled joints of non-rigid PVC and PUR foam are incompatible, due to the migration of plasticizers.



*Figure 5:  
Graph of distance between sheet edge and drilled hole*

The drilled holes must be adequately dimensioned when **fixing to specific points**, in order to also allow for a sheet length clearance of 0.065mm/m•°C or the expansion clearance of 5mm/m(guide value).

In that case, sheet length is deemed to be the greatest existing distance between two holes.

To avoid material breaking at the sheet edge, a distance of 1.5 times the diameter of hole must be left.

Avoid too strong fixing of the screws as well as tapered screw holes that expansion of the sheets is warranted during temperature changes.

Cylindrical countersinks of fittings in the sheet are preferable to conical because with a conical recess, the sheet has no expansion and it can destroy the sheet in case of temperature fluctuations.

## INSTRUCTION OPTIONS

### 6.1 Vertical and horizontal glazing

Necessary thickness of glazing could be determined with below table. Thickness of the glazing primarily depends on the sheet size.

IMPEX<sup>®</sup> HC (Thickness) → 4-sided-clamped → Load of 0,60 kN/m<sup>2</sup>

		Length (mm)					
		500	1000	1500	2000	2500	3000
Width (mm)	500	3	4	4	4	4	4
	1000	4	8	8	8	8	10
	1500	4	8	10	12	12	12
	2000	4	8	12	12		

IMPEX<sup>®</sup> HC (Thickness) → 4-sided-clamped → Load of 0,75 kN/m<sup>2</sup>

		Length (mm)					
		500	1000	1500	2000	2500	3000
Width (mm)	500	4	5	5	5	5	5
	1000	5	8	8	10	10	10
	1500	5	8	10	12	12	
	2000	5	10			12	

IMPEX<sup>®</sup> HC (Thickness) → 4-sided-clamped → Load of 0,96 kN/m<sup>2</sup>

		Length (mm)					
		500	1000	1500	2000	2500	3000
Width (mm)	500	4	5	5	5	5	5
	1000	5	8	10	10	10	10
	1500	5	10	12	12		
	2000	5	10	12			

IMPEX<sup>®</sup> HC (Thickness) → 4-sided-clamped → Load of 1,50 kN/m<sup>2</sup>

		Length (mm)					
		500	1000	1500	2000	2500	3000
Width (mm)	500	5	6	6	6	6	6
	1000	6	10	10	12	12	12
	1500	6	10				
	2000	6	12				

## INSTRUCTION OPTIONS

### 6.2 Barrel Vaults

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IMPEX<sup>®</sup> HC sheets are not suitable for tunnel vaults, the sheets may only be installed in a smooth version, any change in shape of the sheets will damage the abrasion-resistant coating.

### 6.3 Thermal Insulation

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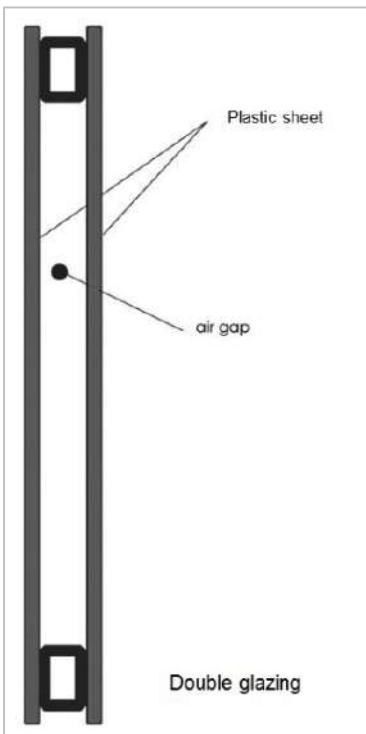
IMPEX<sup>®</sup> HC sheets when used for glazing represent considerable energy cost savings as they prevent excessive heat loss in winter and heat intrusion in summer.

The heat loss factor of IMPEX<sup>®</sup> HC normally referred to as U-value is significantly lower than for glass of the same thickness.

The U-value is the parameter which identifies the heat loss of a building with glazed walls.

**Definition:** The U-value (former K-value) identifies the heat loss in watt per m<sup>2</sup> wall surface and per °C difference in ambient temperature of premises separated by the sheet.

The U-value depends on the glazing assembly.



*Figure 6:  
Example of double glazing*

Examples of the thermal insulation power of IMPEX<sup>®</sup> HC in **single, double and triple glazing systems** are indicated below.

Compared to glass, they show significant advantages as to insulating effect and weight reduction.

**INSTRUCTION OPTIONS**

<b>Installation</b>		<b>IMPEX<sup>®</sup> HC</b>			<b>Window glass</b>	
Sheet thickness (mm)	Air gap (mm)	Composite strength (mm)	U-value (W/m <sup>2</sup> *K)	Weight (kg/m <sup>2</sup> )	U-value (W/m <sup>2</sup> *K)	Weight (kg/m <sup>2</sup> )
<b>Single glazing</b>						
2	-	2	5,54	2,40	5,83	4,96
3	-	3	5,39	3,60	5,80	7,44
4	-	4	5,24	4,80	5,77	9,92
5	-	5	5,10	6,00	5,74	12,40
6	-	6	4,96	7,20	5,71	14,88
8	-	8	4,72	9,60	5,66	19,84
10	-	10	4,49	12,00	5,60	24,80
<b>Double glazing</b>						
2	5	9	3,34		3,55	
2	10	14	2,94	4.80	3,10	9,92
2	15	19	2,77		2,91	
3	5	11	3,23		3,53	
3	10	16	2,85	7.20	3,09	14,88
3	15	21	2,69		2,90	
4	5	13	3,12		3,50	
4	10	18	2,77	9.60	3,07	19,84
4	15	23	2,62		2,88	
5	5	15	3,02		3,48	
5	10	20	2,69	12.00	3,05	24,80
5	15	25	2,55		2,87	
<b>Triple glazing</b>						
2	2 x 5	16	2,39		2,55	
2	2 x 10	26	2,00	7,20	2,11	14,88
2	2 x 15	36	1,84		1,94	
3	2 x 5	19	2,30		2,53	
3	2 x 10	29	1,94	10,80	2,10	22,32
3	2 x 15	39	1,79		1,93	
4	2 x 5	22	2,22		2,52	
4	2 x 10	32	1,88	14.40	2,09	29,76
4	2 x 15	42	1,74		1,92	
5	2 x 5	25	2,15		2,50	
5	2 x 10	35	1,83	18.00	2,08	37,20
5	2 x 15	45	1,70		1,91	

Information on further specific glazing systems can be obtained from our Technical Service Department upon request.

## INSTRUCTION OPTIONS

### 7 CONCLUDING REMARKS

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For more details on further processing methods, please contact our technical customer service.

Please note that our technical recommendations are without legal obligation.

The information given in this instruction options is based on our knowledge and experience to date. It does not release the user from the obligation of carrying out their own tests and trials, in view of the many factors that may affect processing and application; neither do they imply any legally binding assurance of certain properties or of suitability for a specific purpose.

It is the responsibility of those to whom we supply our products to ensure that any proprietary rights and existing laws and legislation are observed.

Technical data of our products are typical ones; the actually measured values are subject to production variations.