



# Gelshield Plus Application Manual

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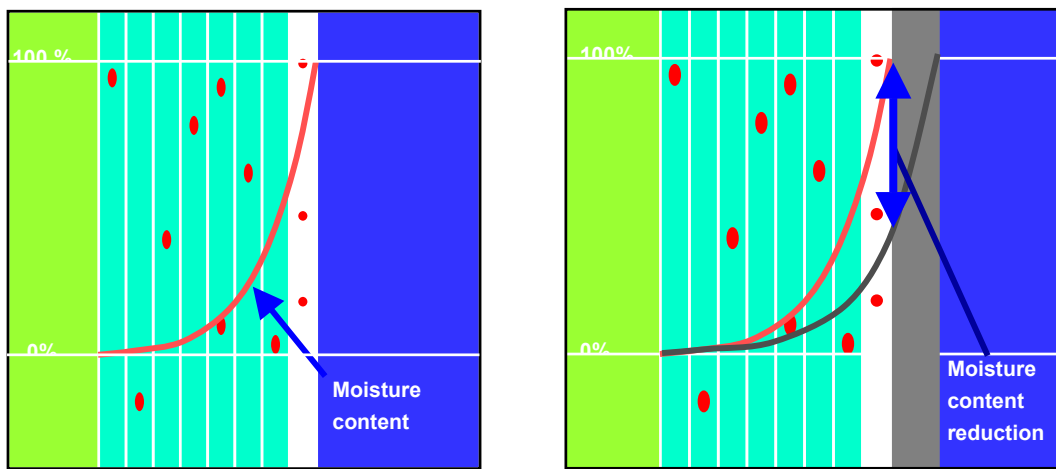
# Introduction

## **Osmosis, Gelshield Plus and Associated Products**

Since the introduction of GRP vessels into the marketplace as long ago as the mid 1960's it has been clearly demonstrated that fibreglass boats are not the maintenance-free vessels they were once claimed to be. Time and use takes its toll and the appearance of yachts gradually deteriorates. "Osmosis" has for some time been a recognised problem affecting a certain percentage of boats.

The best way to prevent osmosis in a yacht is to separate it from water. This can easily be achieved with the use of Gelshield epoxy coatings applied to the underwater area of the hull. Gelshield epoxy reduces the level of water penetration into the hull, which is the key to success in combating osmosis.

### **The effect of epoxy coatings on hull laminate moisture levels:**



**Unprotected**

**Epoxy Protected**

The Gelshield System from International provides a solution to the differing challenges of both protection and treatment.

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# Understanding and Assessing Osmosis

## Introduction

Glassfibre became prevalent in the mid 1960's. It was the first boat building material that relied on the boat builder chemically creating the material at the construction stage. The convenience and consequent popularity of this method of building is reflected in the speed with which GRP/FRP became the dominant boat building material.

As with many new products, a number of claims were made. Two of these claims – namely that GRP/FRP was both maintenance-free and everlasting – were over-optimistic. The myth about GRP being a no-maintenance material was dispelled within a year or two of its introduction; fouling grew well on GRP and therefore antifouling had to be applied.

It was only in the mid 1970's, however, that evidence emerged of a much more serious shortcoming of GRP. Simply put, GRP deteriorated underwater, in some cases very early on in the yacht's life. This deterioration process has become known as 'osmosis', after the physical mechanism by which many cases of deterioration are caused, although it is not "osmosis" in the strictest definition of the term.

In the particular context of yachts, the term 'osmosis' has come to be applied to a whole spectrum of gelcoat and laminate defects, which usually manifest themselves as blisters in the gelcoat, in most cases after immersion in water.

This text includes:-

**An indication of the main gelcoat and laminate defects, and their causes.**

**Assistance to surveyors, boatyards and boat owners in identifying the type of problem that may exist in a GRP/FRP hull.**

**Specification of protective and remedial treatment schemes developed by International, based on a detailed scientific understanding of the problem.**

## Overview of the Osmosis Research Programmes

In the period following the emergence of osmotic blisters as a problem affecting GRP yachts, it was thought that the paint was at fault. International therefore initiated major research into the subject, with the intention of understanding and eventually solving the problem.

Very early on, however, it became apparent from a thorough examination of many sets of paint flakes that the destructive pressure was building up not in the paint film but behind it, within the GRP, and that it was this internal pressure that was causing the paint to blister. A programme of investigation was launched to look more closely at the laminate and gelcoat used in yacht hulls. The characteristics and differences of osmotic laminates and osmosis free laminates were isolated and compared in order to establish clearly where the problem began and how it was propagated.

Further research identified the major undesirable chemical reactions taking place in the laminate, and has contributed to the development of products and treatment methods that significantly extend the life of yachts.

A series of tests and trials to determine what produced the best barrier properties was undertaken at the same time as numerous practical applications to confirm the characteristics necessary to ensure ease of application in a boatyard environment.

The result has been two key products that are at the heart of the Gelshield system. These were originally Gelshield and Gelshield 200. With the advancement of ongoing research and the availability of new materials technology Gelshield has now been superseded with the introduction of Gelshield Plus.

## **General Symptoms and Causes of Osmosis**

Polyester resin is used in the lamination of most "GRP/FRP" yachts. This resin, which comes in the form of a viscous liquid, is manufactured by the reaction of a polyfunctional acid with a polyhydric alcohol. A linking reaction takes place in which the water generated in the reaction of the basic ingredients has to be removed.

To turn this into a solid, the boat builder adds peroxide, which acts as a catalyst and causes the viscous liquid to react and become converted into a solid.

The process of osmosis is usually attributed to one of three root causes:

**Water ingress from outside the yacht.**

**Water ingress from the inside: bilges, for instance.**

**Reactive impurities in the resin.**

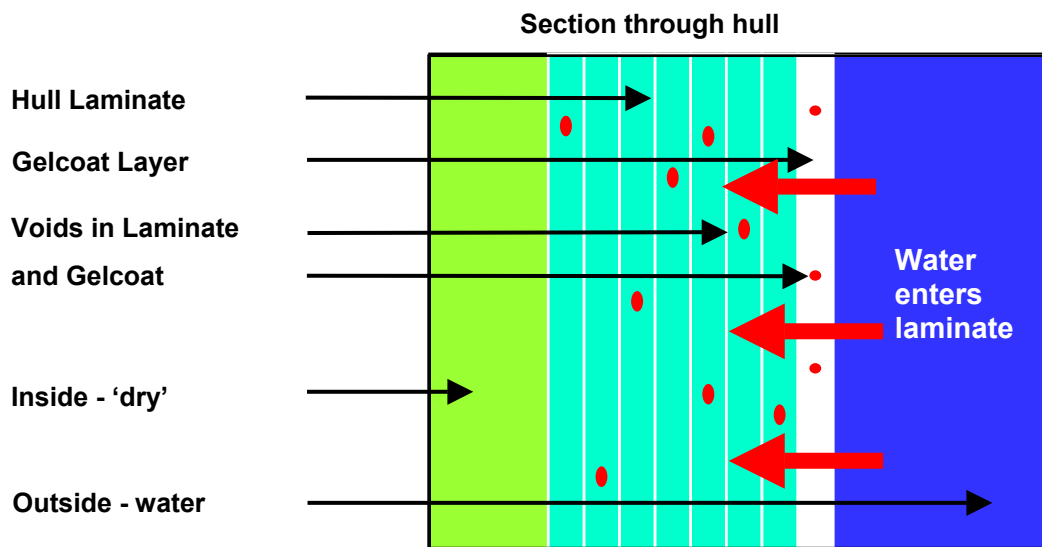
Water ingress has been found to be the cause of the problem in about 85% of all cases analysed. Such cases can now be treated with good effect. In this situation water reacts with the impurities in the laminate or the polyester itself, or the coating agent on the glass reinforcement to form free acidic substances. In this process, known as hydrolysis, the resin becomes broken down into its component parts by the water. However, it is worth noting that all polymeric materials (plastics) are permeable in water and to water vapour to some degree but it is the fact that in the manufacturing process of the resin certain traces of un-reacted constituents leads to breakdown and ultimately the onset of what is referred to as "osmosis".

The remaining 15% of cases, where reactive impurities or lamination deficiencies are the cause of the problem, are the most difficult to treat. It is possible that the chemical reaction at the resin-manufacturing stage is incomplete; that is, about 0.1% of the acid or alcohol remains 'free' in the resin. In such cases, the resin supplied to and used by the builders is incapable of being completely reacted. Effectively, the 'free' molecules of acid or alcohol are available to participate in secondary, undesirable and unintentional chemical reactions within the laminate. Additionally the peroxide catalyst and any other accelerators used do not form part of the solid matrix and similarly exist as impurities in the laminate. Trace constituents are known to react with elements in water generating compounds that create pressure, which is evidenced as blisters in the gelcoat.

The problem often manifests itself in the first two or three years of the hull's life. Such cases exhibit a great deal of variation, and even when a successful analysis has been made it is not always possible to stop the reaction continuing. Treatment of such cases is, therefore, sometimes impossible and cannot be considered 100% successful although it may well prolong the hull lifespan.

## Stages of Osmosis

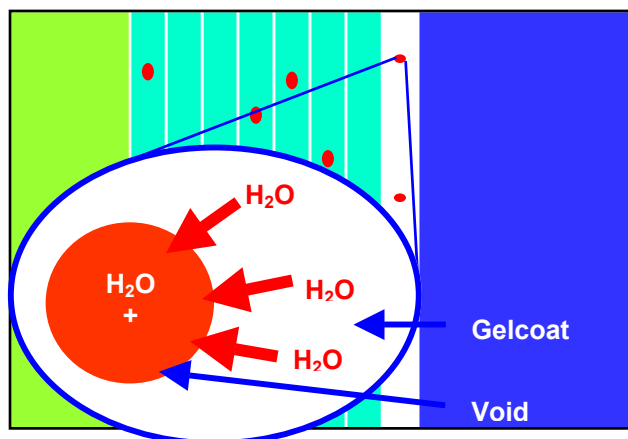
### Stage 1 – Water Penetration



### Stage 2 – Solutions form in Voids

Initially in the Gelcoat, where the moisture content is higher. And then deeper in the laminate as the condition progresses.

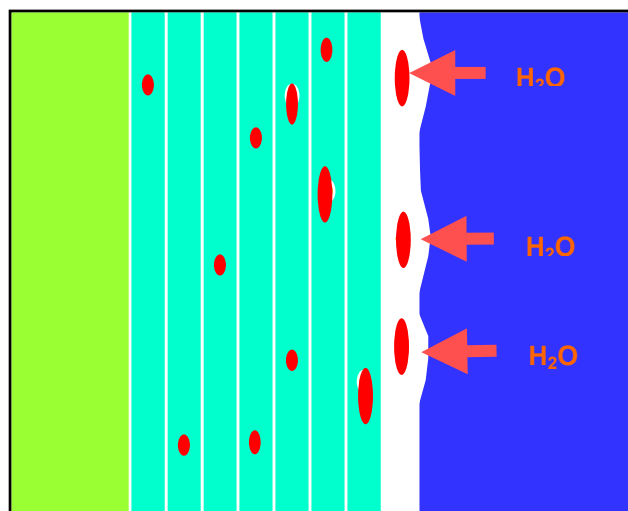
The moisture present starts to break the resin down by hydrolysis.



### Stage 3 – Blister Formation

The concentration cells formed draw in more moisture that causes blisters to form and swell.

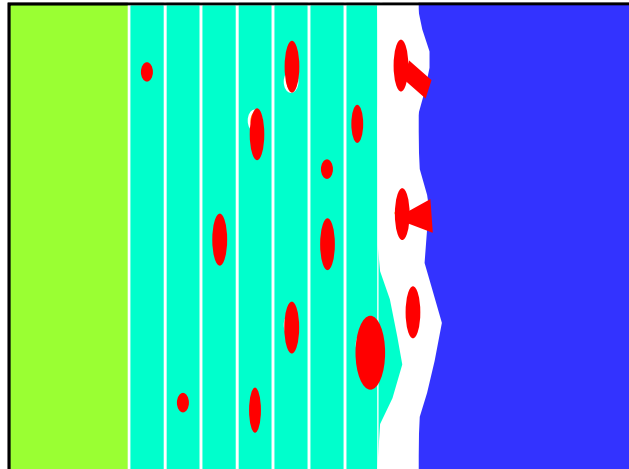
The increased pressure also tends to accelerate the breakdown of the laminate resin.



#### Stage 4 – Laminate Failure

Continuing resin breakdown and increasing pressure in blisters leads to some blisters bursting.

Deeper in the laminate, large blisters cause laminate breakdown and eventual failure.



#### Contributory Factors

There are a number of factors at the building stage that can combine to produce a hull lacking the ability to resist osmosis over an extended period of immersion. These factors include both the standard of raw material used in the construction, the workmanship, or a combination of both.

##### Raw Material Issues

**Emulsion-bound glass; Glass matt requires a coating agent on the fibres to hold the fibres in place prior to use and enable resin to adhere to it. When an emulsion (usually a modified PVC/PVA compound) is used, this is water-sensitive; it reacts with free water in the laminate to produce the characteristic pungent, vinegary fluid (acetic acid) found in blisters. Powder bound matt is preferred for this reason.**

**Porous gelcoat caused by under-reaction of resin at its manufacturing stage.**

**Water-sensitive pigments used in the gelcoat. Certain blue and red pigments are known to be hydrophilic.**

**Water in the resin: During the manufacture of the polyester resin quantities of water are produced. This water should be removed at the manufacturing stage; occasionally, small quantities remain as an impurity.**

**Glass matt stored in a damp place and then used in a slightly wet condition.**

There are a number of cases where the raw materials used in construction are sufficiently far off standard as to have made the entire laminate unstable. Two of the more common examples are:

**Acid-rich resin.** Occasionally, in the production of the resin, an excess of acid remains after the acid/alcohol reaction stage. This leaves free acid, making the resin prone to blistering. The reverse could happen and there could be alcohol excess.

**Peroxide catalyst strength below requirement.** The peroxides used as a catalyst in the production of GRP are relatively unstable substances with a limited storage life. Use of old, out-of-date or poorly stored catalysts can result in a seriously under-cured resin.

In these cases, the reaction is irreversible once started, and the hull cannot usually be successfully rectified.

## **Workmanship Problems**

**Under-cured, soft gelcoat caused by insufficient catalyst.**

**Brittle gelcoat caused by excessive amounts of catalyst, often evidenced by 'star' crazing.**

**Aerated or pinhole-blistered gelcoat, reducing its effective thickness.**

**Gelcoat not bonded to the laminate, due to the gelcoat being allowed to cure for excessively long periods before commencement of lamination.**

**Matt behind gelcoat not wetted out with resin, allowing moisture to 'wick' down fibre and into laminate.**

**Stray matt fibres pushing into gelcoat, reducing its effective thickness.**

**Poor wetting-out of fibre on the hull interior, allowing water to be drawn in from the bilges.**

**Resin-to-glass ratio: the manufacturer normally defines the correct resin/glass ratio for a particular laminate. When the resin percentage is allowed to fall significantly, a dry and porous lay-up results.**

**Poor resin-to-glass adhesion affected by the type of size or coating agent applied to glass fibre during manufacture.**

## **Water Temperature and Salinity**

For all types of osmosis, the laminate temperature, defined by the temperature of the water in which the hull is immersed is a key factor. The process of osmosis is based on a series of chemical reactions and as such a warmer laminate will degrade faster than one in colder conditions.

The salinity of the water is also important. Water not only seeks to fall to a level but also will seek to dilute any concentrated solutions. Thus, the moisture attracting effect of the highly concentrated solutions in the voids and blisters is most severe in fresh water where the concentration difference is greatest.

For these reasons, two identical boats will display apparently different resistance to osmosis if one is kept in a fresh water lake where it is warm enough to stay afloat all year around and the other is in a salt water environment where it freezes each year and the boat spends several months out of the water.

## Identifying Potential Problems at an Early Stage

### Visible Evidence

By inspecting a hull with the aid of a strong magnifying glass (10x or greater), it is possible to see on the hull surface indications as to whether the laminate is prone to water absorption. The following defects, if seen above the waterline, are likely to be repeated below the waterline, underneath the antifouling where they can often escape notice.

**Star crazing.** Evidence of star crazes indicates that the gelcoat is brittle and may have been rapidly reacted. Water will seep in through the cracks.

**Micro-cracks.** Any micro-cracks in the gelcoat will exhibit the same tendency.

**Pinholes.** Small pinhead-sized bubbles in the gelcoat that will either have burst or shown up as little voids. This indicates that the effective gelcoat thickness is much less than it should be below the waterline. In turn, this will allow water to penetrate the hull more easily; the thinner the gelcoat the quicker water will be absorbed.

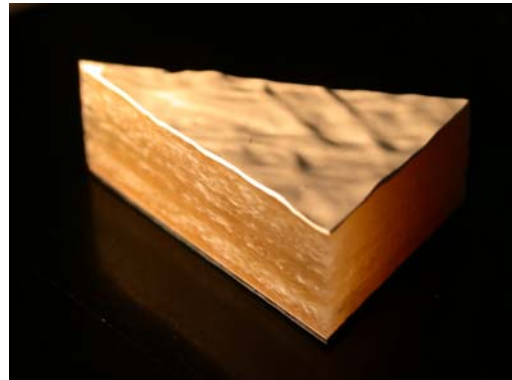


Surface of GRP laminate magnified 32x showing pinholes in the pigmented surface

**Prominent fibres.** These can sometimes be seen protruding either beneath or through the gelcoat. This allows 'wicking' to occur, this being defined as the process by which water is drawn into the hull by capillary action.



Surface of a GRP laminate showing prominent fibre magnified 32x



Section of a laminate removed for examination showing prominent fibre in pigmented gelcoat

**Blisters. These normally occur only below the waterline and are usually evidenced as bubbling of the antifouling. In this eventuality the antifouling will need to be removed to enable the underlying cause of the problem to be ascertained.**



### **Invisible Evidence**

A number of laminate defect symptoms are not visible to the naked eye. Such problems as under bound glass and weak structure can probably be found only by more thorough analysis. The removal of a glassfibre core – such as the ‘plug’ that is removed when a skin fitting is installed – can give a great deal of information.

For example:

**There may be evidence of de-lamination in the structure.**

**Further bubbles, previously hidden by the pigment, may now be visible within the thickness of the gelcoat.**

**The resin/glass ratio may be incorrect. It is possible to determine the resin/glass ratio by performing a relatively simple test.**

### **Evidence of Water Absorption**

It is not easy for the owner to know whether water absorption has taken place unless this has occurred to such a degree that the vessel floats visibly low. On larger vessels this will be less noticeable.

Meters used to detect moisture in Yacht hulls typically work on the principle of electromagnetic conductivity. Often it has been found that a high reading has not been due to moisture content but some other factor.

### **Examination of Blister Fluids**

The appearance of blisters below the hull waterline is the key indication that a laminate problem exists. The blisters take the form of a dome or, if pressure has caused them to break, possibly a crater.

Analysis of the blister fluid is the usual method of determining the type of problem within the hull. There are three characteristics that can be quite easily tested on-site:

- The smell of the blister fluid: A strong vinegary odour (often mistaken for styrene) indicates the presence of acetic acid, which is highly reactive. Pressure builds up in the hull when the acid reacts with various substances; the chief problem is calcium, which is present in both fresh and salt water and forms calcium acetates. This chemical reaction causes sufficient pressure to form a blister. There is usually sufficient free acetic acid in the blister fluid for the smell to be apparent.
- The feel of the blister fluid when rubbed between finger and thumb. A greasy feel, similar to that of washing-up liquid or antifreeze, is due to the presence of glycol in the resin. This free glycol is soluble in water.

- Its acidity or alkalinity is determined by the use of pH paper. Testing the blister fluid best takes place at the moment the blister is broken and the fluid released. The neutral reading – as in the case of distilled water – is pH 7. Readings usually found for GRP blisters are:

**pH 5-pH 6: Acid reading.**

This is by far the most common result, and indicates that free acid has hydrolysed off the emulsion coating forming acetic acid and other acetic compounds. Occasionally readings as low as pH 4 have been found.

**pH 7** is neutral and is sometimes found in vessels located in brackish or freshwater moorings.

**pH 8-pH 8.3: Seawater-filled blisters.**

Water has penetrated the gelcoat.

**pH 9: Alkaline reading.**

This is very rare and indicates that amine accelerators have been used either at the laminate stage or, just possibly, at the resin manufacturing stage. This is very unusual in more modern hulls, so the implications are not discussed here.

## Assessing the Extent of the Problem

The recommendation from International to owners of a yacht affected by blisters is to request an inspection by a surveyor. The aspects that will typically be considered by the surveyor in the course of his inspection will include the age of the vessel, the nature and extent of the blistering, and an assessment of how much of the gelcoat will need to be removed.

The study of the osmosis problem, by International, leads to the following observations: -

### Age of the vessel

A blistered yacht, which is less than 3 years old, should be referred to the builder, as this is unusual and therefore it is likely that the cause of the problem will be of particular interest to them.

Blistered gelcoats in yachts that are more than 5 years old may indicate that the laminate quality is compromised in some way, but the problem can probably be treated effectively.

Hulls which have turned in a satisfactory performance for over 10 years are probably well built but suffering from gradual breakdown of the gelcoat and consequent water penetration. There is a high probability that treatment will extend this trouble free performance.

### Nature and Extent of the Blisters

The surveyor should define whether the blistering is localised or general; there is no point in removing the complete gelcoat if only a small area is affected. In this case it is important to identify the type and probable cause of the blistering to understand if there are implications for the remainder of the hull:-

**Pinhead blistering emanating from pinholes can indicate a badly mixed gelcoat; other signs will tell whether a chemical reaction is the cause.**

**Blisters should be broken to discover whether they are fluid-filled or dry. If the former, the fluid should be tested with pH paper.**

**The blister crater should be examined for evidence of stray fibres and dry matt laminate. If considered necessary, a small part of the gelcoat should be removed to find out how well it is adhering to the matt in the laminate below.**

**If the laminate looks very dry, a resin-glass ratio test should be undertaken.**

### Area of Hull to be treated.

In a severe case affecting a large area, most or all of the gelcoat will have to be removed if the hull is badly affected and there are possibly some underlying laminate causes. In the case of a few random blisters, treatment may be a relatively simple matter of cutting them out and treating individually.



## **Treatment and Protection Options**

Depending on the results of the survey three basic options can be considered:

### **Option 1.**

**Survey result:** Gelcoat in sound condition, no evidence of osmosis.

**Recommendation** – Protection system.

Even though no osmosis appears to be present there is a continuing risk for all GRP/FRP boats. To minimise this, apply a thick epoxy coating (**Gelshield 200**) to the hull to create a separation layer between gelcoat and water. This will delay the onset of any osmosis that is likely to occur.

### **Option 2.**

**Survey result:** Evidence of osmosis including blistering in the gelcoat.

**Recommendation** – Treatment system

Full removal of the gelcoat is likely to be required and replacing the gelcoat with the recommended film thickness of **Gelshield Plus** epoxy barrier coating after thorough cleaning and drying.

### **Option 3.**

**Survey result** – extensive blistering and craters in gelcoat and underlying laminate.

**Recommendation** – Removal of gelcoat and affected areas of laminate.

Thorough cleaning and drying prior to re-lamination with **Epiglass** epoxy resin system and application of **Gelshield Plus** epoxy barrier system

# Protecting Hulls and Rectification of Osmosis

## Option 1 – Protection System

### Description of System

A vessel with no signs of osmosis will benefit from protection against osmosis. The earlier this is done, the greater the benefits, and some manufacturers are applying **Gelshield 200** to their hulls either as an option or as standard equipment.

**Gelshield 200** is an epoxy barrier system that serves the dual function of the barrier system and antifouling tie coat. Once the recommended thickness has been applied it can be over-coated by any of the antifoulings in the International Range.

**Gelshield 200** is an epoxy primer with specific formulation characteristics developed to offer easy application by a variety of methods whilst consistently delivering a high level of protection against osmosis. The solvent based epoxy technology delivers extremely good adhesion to the surface and very good tolerance to a wide range of application conditions and temperatures. To augment the barrier properties of the epoxy, layered mica has been incorporated within the formula that creates an interlocking Microplate<sup>®</sup> effect within each coat, which is highly effective in combating water penetration.

It will also protect metal fittings from corrosion, and so a single product can be applied to hull, sterngear and skin fittings to provide maximum protection to all underwater parts of the vessel.



**Gelshield 200** can be applied directly to the gelcoat after the appropriate preparation. Roller, brush or conventional sprays are appropriate application methods, whilst airless spray has the advantage of being able to deliver the greatest coating thickness in each application, reducing the time to complete the project.

Once cured, the full range of antifoulings from International can be applied direct to **Gelshield 200** as it functions as an antifouling tie coat as well as a primer. If the application is completed within the overcoating time specified, no sanding is required between coats of **Gelshield 200** or subsequent antifouling layers.

### Surface Preparation - GRP/FRP and Composites

#### Introduction

As with any painting project, correct preparation is essential if early failure is to be avoided. Depending on the construction method employed, the surface to be coated will have characteristics which will require specific steps in preparation before the project can proceed.

#### Moulded GRP Surfaces

Fibreglass hulls and components are often made in a mould and therefore it follows that to release them from the female mould, a release agent of various types will have been used. These can vary between silicone-modified waxes, hard pure waxes and water miscible polyvinyl alcohol release agents. In the case of some GRP/FRP composites the mould is a male mould and the release agent is therefore on the inside of the structure rather than the outside.

In either case, the release agent must be removed before painting can commence by emulsifying with detergent before thoroughly washing. A key indicator to thorough removal of release agent is that the surface will become fully wetted with water if all mould release agent has been removed. If release agents remain, water will remain in droplets on the surface. In this instance the process should be repeated.

#### GRP Laminate Surfaces

Occasionally, an entire hull may be made on a male mould using polyester resin. In this instance, the outside of the hull will not be a smooth gelcoat finish but rather a rough laminate finish. Typically this type of surface will require abrading to remove the outer layer of resin. This will often be slightly tacky as a result of the 'air inhibition' of cure at the surface of polyester

laminates and this can be a guide to determine if the outer layer has been removed correctly. The water-wetting test is also effective in this situation.

If a peel-ply has been used, abrading will not be required, as the outer layer will be removed with the peel-ply.

### **Preparation Summary**

For the moulded face of the substrate, any mould release agent must be thoroughly removed by detergent cleaners or special solvents, and possibly sanding.

Gelcoat surfaces should then be checked for:

#### **Pinholes**

If present these should be filled prior to painting.

#### **Star Crazes**

Very difficult to detect and sometimes only show up after the first coat of paint has been applied. They should be ground out and filled with Interfill 830

#### **Blisters**

This may indicate moisture is present, so the hull should be checked for osmotic attack using a moisture meter. If osmosis is present the gelcoat will need to be removed and an osmosis treatment scheme applied.



All surfaces should be abraded with 180 - 220 grade papers to ensure a good mechanical key is present.

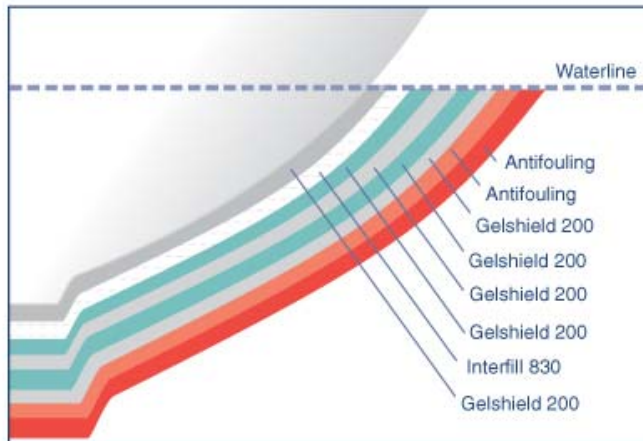
### **Application**

**Brush/Roller** are widely used methods of application. It should be noted that the film thickness of Gelshield 200 when applied by this method would generate dry film thickness in the order of 50 microns. For suitable degrees of protection, ensure the overall dry film thickness recommended is achieved.

**Conventional Spray** application demands that the material is thinned to allow for passage through a conventional spray gun. It is advised that wet and dry film thickness are regularly checked to ensure adequate amounts of material are deposited on the surface

**Airless Spray** allows for the material to be applied un-thinned with the result that much higher dry film thickness can be achieved per coat. Given the higher build it is advised that you check the product data sheet is carefully checked to ensure overcoating times are met. They differ from those resulting from the methods of application mentioned previously that deposit a lower thickness of material

## Suggested schemes for users of Gelshield 200



### Gelshield 200 applied by Brush/Roller or Conventional Spray:

**Gelshield 200** (Grey) @ 110 microns WFT = 50 microns DFT

**Interfill 830** as required

**Gelshield 200** (Green) @ 110 microns WFT = 50 microns DFT

**Gelshield 200** (Grey) @ 110 microns WFT = 50 microns DFT

**Gelshield 200** (Green) @ 110 microns WFT = 50 microns DFT

**Gelshield 200** (Grey) as an antifouling tie coat @ 50 microns DFT

2 coats **International Antifouling**

### Gelshield 200 applied by Airless Spray:

**Gelshield 200** (Grey) @ 300 microns WFT = 135 microns DFT

**Interfill 830** as required

**Gelshield 200** (Green) @ 300 microns WFT = 135 microns DFT

**Gelshield 200** (Grey) as an antifouling tie coat @ 50 or 135 microns DFT depending on type of application

2 coats **International Antifouling**

In all cases the application process is simplified by the fact that **Gelshield 200** is a primer, barrier and tie coat.

1. Prepare the surface according to the condition of the substrate found. Previously painted surfaces should have all layers of paint removed. New gelcoat will have traces of mould release which will need to be removed. Follow the guidelines on preparation outlined above.
2. Wipe down the surface to be painted with solvent and a clean cloth. Use either Thinners No. 3 or Thinners No. 7 (*For large jobs YTYA910 could be used for this purpose as it is supplied in 5 litre tins.*) A different clean cloth should be used to remove any excess solvent.
3. Apply the first coat of **Gelshield 200** by the chosen method.
4. After an appropriate drying period (refer to the datasheet), apply any filler that is required. For small areas **Watertite** epoxy filler can be used. This is a faster curing filler suited to small repair areas. Interfill 830 is most appropriate for larger areas as it has a longer working time and is easier to sand once it is cured.
5. After any filler application, wipe down with solvent and a clean cloth as before.
6. Apply subsequent coats of **Gelshield 200** by the chosen method taking care to observe the minimum overcoating times shown on the product datasheet.
7. Apply **International Antifouling** direct to **Gelshield 200**. This can be done without sanding provided the maximum overcoating time has not been reached.

## Option 2 – Treatment System

### Description of System

Any yacht affected by osmosis will need to have all or part of its gelcoat removed. By definition, a 'dried out' glass matt from which the gelcoat has been removed is itself an unsound porous surface, and it follows that application of a coating over this type of substrate carries a certain degree of risk.



**Gelshield Plus** has been developed specifically to minimise these risks. It has the following key attributes:

#### Two Component Chemically Curing Epoxy

It is a two-part, chemically curing epoxy product with a 2:1 mixing ratio. Epoxy has been chosen as being a highly impermeable resin. Further, unlike polyesters that have very critical mixing ratios, it is easy to mix in the boatyard environment. Epoxy resins are not susceptible to the hydrolysis that is the root cause of typical GRP osmosis.

### Solventless Formulation

The benefit of a solventless formulation is that there is no chance, of solvent migrating into the porous matt surface and becoming entrapped in those voids previously occupied by the "osmotically" introduced water; this would later create problems. One accompanying and desirable feature of the solventless formulation is, of course, that the operator is not subjected to an unpleasant solvent smell.

### High-build Characteristics

Generally, the thicker the coating the more water-impermeable it becomes. **Gelshield Plus**, being 100% solids, can be applied up to 150 microns thick for the first coat; an effective barrier can be built up with only 4 coats. Experience with ordinary epoxies indicates that a total film thickness of at least 200 microns is required for osmotic boats. The recommended **Gelshield Plus** scheme will normally well exceed this figure.

**Gelshield Plus (Base YAA222 Curing Agent YAA221 Blue, YAA220 Green)** is an alternative development in high build solvent free epoxy for areas preferring pigmented epoxies whilst retaining the highly protective element and extremely low water permeation characteristics of original Gelshield. The alternating colours aid visibility when building up the scheme. It has inherent hold up characteristics higher than those associated with the original Gelshield, thus giving the potential to use one less coat than in previous specifications (osmosis treatment schemes of 4 coats as against 5 coats for the original product). Additionally, it has a simplified mix ratio of 2:1 and the ability to cure at temperatures down to 10°C, some 4 degrees lower than the original version. Compatibility with **Interfill 830** and **Interfill 833** remains unchanged.

Accompanying these positive characteristics are three aspects that must be borne in mind by any user of **Gelshield Plus**:

### Exothermic Reaction

When the base material and catalyst have been mixed, an exothermic chemical reaction begins (i.e. heat is given off). If the product is left in the container it will heat up, fume and cure in about 10/15 minutes. Immediately after mixing, therefore, it is important that the material is poured into a wide, shallow tray to a depth of no more than 2.5cm so that the heat of the exothermic reaction is easily dissipated. International recommends to mix no more than can be used in half an hour.

### Not Suitable for Spraying

Once cured there is no known solvent for **Gelshield Plus**. Spray equipment in which Gelshield Plus is inadvertently allowed to cure will be permanently damaged. For this reason, it is recommended that the product is not sprayed.

## Health and Safety

As reactive chemicals, all epoxies present a small element of risk to the user. International strongly recommends that the user should study and observe the Health and Safety recommendations on the label. Material Safety Data Sheets (MSDS) are available on request.

## Preparing for Treatment

### Removing the Gelcoat

There are five general methods of removing the gelcoat:

- **Gelcoat Peelers:**



In recent years this has become the most popular way of removing antifouling coatings and blistered gelcoat. The two invariably go together with the antifouling, however long in service, presenting a toxic hazard. Gelcoat Peelers have the advantage of removing both substances into containers without a toxic hazard whilst at the same time retaining the contour of the hull.

Care should be taken in setting the blades on the power plane to a suitable depth for removal. It is advisable after peeling to lightly grit sweep or grind the surface to expose any deep-seated voids and to give a sound mechanical key.



- **Disc grinding:**

This method is not the most reliable to get an even result and can therefore only be recommended for relatively small areas. A large circular grinder is used to grind out gelcoat and blisters alike. A considerable amount of dust is produced, so the operator must wear the appropriate mask and protective clothing and simultaneously ensure that other people in the vicinity are not affected.

- **Hot Vac Treatment:**

Hot Vac treatments are increasingly popular because the boatyards claim they are very effective in the removal of absorbed water and some other impurities from affected hulls.

They operate on the principle of controlled heat combined with high vacuum conditions that speedily vaporise many impurities. The heating blankets conform tightly to the hull surface ensuring an evenness of substance removal.

- **Slurry blasting:**

Although this method is expensive, messy and requires special equipment, it has proved so successful as a method of complete gelcoat removal that there are now a number of specialist operators with a mobile facility who can carry out this work. It is best that the yacht should either be positioned in an isolated place or surrounded with suitable screens. The blasting should be carried out wet, using a low pressure of 60-80 psi (4.2-5.6 bar) and certainly no more than 100 psi (7.0 bar) to ensure that the laminate is not damaged and that grit is not embedded in the hull.

- **Heat gunning:**

Heat gun paint removers can be used to remove the gelcoat. Heat gunning is slow, but with care a reasonably smooth service can be achieved.

A number of important points should be borne in mind when using a heat gun to remove gelcoat:

**It is dangerous to heat up the residue of antifouling; toxic fumes may be emitted.**

**Care must be taken not to overheat the resin/matt layers beneath the gelcoat; this would harm the structure of the hull.**

**It is important that all antifouling is removed with the gelcoat. Even a speck of antifouling left on a hull and over-painted has been known to start off blistering again at a later date.**

**Care must be taken to scrape off all the gelcoat. With a heat gun, it is easy to merely smear over the blisters instead of removing them entirely; subsequent application of Gelshield would simply re-incorporate the blisters under the new coating, making a recurrence more likely.**

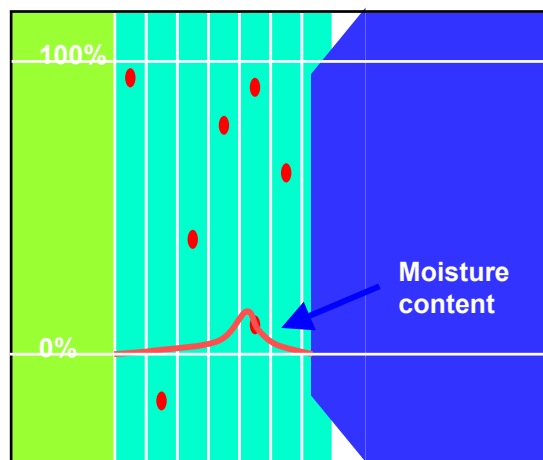
## Drying Out

After removing the gelcoat, the hull should be thoroughly washed off with fresh water to remove salt, dirt and any soluble residues. If this can be done with hot water or steam cleaning a better result will be achieved. The hull should then be left to dry out. The purpose of the drying stage is to allow all water in the hull and any remaining surface chemicals to evaporate into the atmosphere. If drying is to take place in the open air, the hull should be fresh water pressure washed or steam cleaned on a regular basis. Use of a dehumidifier chamber, accelerated drying (dehumidifier, infra red, vacuum or Hot Vac treatment) will considerably shorten this period.

After the drying period has elapsed, the hull should be tested for dryness. This can be done by using a suitable moisture meter but in all cases it is recommended that the following physical check is also carried out: -

Fix a 1-foot square (30 centimetres square) piece of transparent plastic sheeting to the hull with adhesive tape. Leave for 1 hour. If after this period has elapsed no condensation appears on the plastic sheet, it can be assumed that this area is free from moisture. This is not so effective at elevated temperatures and can only be used as a general guide.

The purpose of this test is to see if there is moisture deeper in the laminate that may not be revealed by the meter test. As shown in the diagram, moisture quickly evaporates from the surface whilst remaining deeper in the laminate. This situation can also develop if the solutes and impurities are only washed out of the outer layers of laminate. In this instance it may be necessary to remove more layers of laminate.



## Recommended Application Procedures

If after making a thorough inspection of a yacht affected by osmosis, the surveyor feels that treatment has a good chance of success, the following application programme is recommended: -

### 1. Temperature and Dryness Check

Before starting, the yacht should be positioned in a workplace where the ambient temperature is unlikely to fall below 10°C. A final check should be made on the dryness of the hull.

### 2. The First Coat of Gelshield Plus

The first coat of **Gelshield Plus** should be mixed and used to impregnate and seal the surface. Brush it on as thickly as possible without allowing sagging to occur (sags, if they occur, will normally appear about 15 minutes after the application). Use a relatively stiff brush, ensuring that the **Gelshield Plus** is stippled into all voids and that every stray fibre is bedded down into the matt; the latter point is essential if wicking is not to occur subsequently. A coating thickness of 150 microns should be achieved; this figure may be verified using a suitable wet film thickness gauge or by checking the volume applied to the surface is a minimum of 150ml per sqm. Alternatively for very rough laminates use shims to determine what film thickness you are applying.

Some users prefer to use **Epiglass** epoxy resin in place of the first coat of **Gelshield Plus**. Epiglass is a solvent free clear epoxy. The clear characteristic of Epiglass can be beneficial during application of the first coat onto the glass matt; because the applicator can visually check to ensure that all stray fibres have been bedded down and that the material has been worked into every indentation. In hot weather or for particularly smooth substrates, Epiglass may be thickened by the addition of **Glue Powder (YXA110)**.

### 3. The First Application of Filler

In most cases it will be necessary to fill the laminate surface to return the hull to a smooth shape. Filling may commence as soon as the first coat appears to be hard; at 20°C, this will typically occur approximately 4 hours after application. It is best that filling is carried out within 24 hours of applying the first coat of Gelshield Plus. If unavoidably left longer than 48 hours, the coating should be abraded with 180 grade wet and dry abrasive paper, used wet.

Filling should be undertaken with **Interfill 830 Epoxy Profiling Filler (YAA867/YAA868)**, which is also a solvent free material. This filler has been formulated for application over large areas in a thickness of up to 2cm. It can be applied using a plaster trowel and screeded off with a batten. When applying the filler, care should be taken to ensure that it is worked thoroughly into all indentations and crevices. It is essential that no voids are allowed to remain. The ideal, experienced operator should be able to achieve a 95% smooth surface at the first attempt. Do not apply a thicker coating of filler than is strictly necessary.



(**Note:** When working at temperatures between 10 - 15°C it is advised that the fast cure version of **Interfill 830 (YAA867/YAA869)** is used as an alternative to the standard cure version. Consult the data sheets later in this manual.)

#### 4. The Second Application of Filler

If further small areas need filling, or if imperfections remain after the first application of filler, use **Interfill 833 Epoxy Finishing Filler (YAA813/YAA814)**, which is also solventless. This is of a smoother consistency than **Interfill 830** and can be applied to a thickness of up to 3mm without sagging.

(**Note:** A fast cure version of **Interfill 833 (YAA813/YAA815)** is available – consult the Interfill datasheets at the back of this manual. These versions are ideal for limited area repairs or filling at lower temperatures).

#### 5. Final Sanding

After the final filling has been allowed to cure for 24 hours, the hull should be sanded smooth as necessary. Ideally, the method of filling should minimize the amount of sanding necessary.

#### 6. The Second Coat of Gelshield Plus

The second coat of **Gelshield Plus** can now be mixed and brushed on. It should be applied using a roller. Roller application will produce a film thickness of around 150 microns, which provides the maximum protection without producing sags. If, on curing, any sags become apparent, they should be removed with a sharp plane, chisel or scraper.

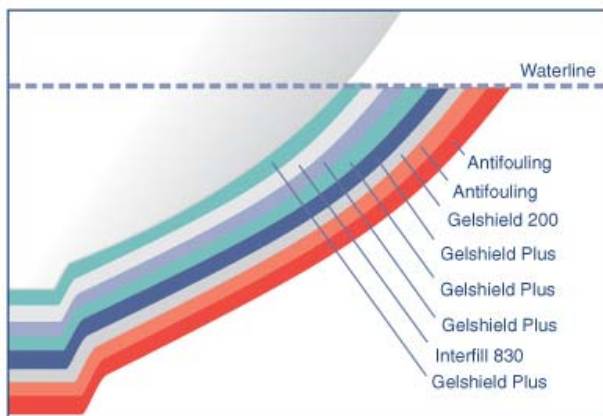
#### 7. The Third and Forth Coats of Gelshield Plus

Allow adequate time for the second coat to cure. (Consult product datasheet for details) If long periods of exposure elapse between coats it may be prudent to abrade the **Gelshield Plus** with 320-grade wet and dry abrasive paper used wet prior to recoating.

The forth and final coat of **Gelshield Plus** should then be applied. Make sure that the curing agent is fully incorporated into the base material and has produced a uniform colour.

#### Tie Coat for Antifouling

The final step is to apply antifouling. Choose one antifouling and use this coating for the entire antifouling scheme. Apply **Gelshield 200 (YPA212/YPA214)** grey tie coat prior to antifouling application.



#### Suggested schemes for users of Gelshield Plus (YAA220 series)

**Gelshield Plus used in the manner described is the typical scheme:**

**Gelshield Plus (Green) @ 150 microns**

**Interfill 830 as required**

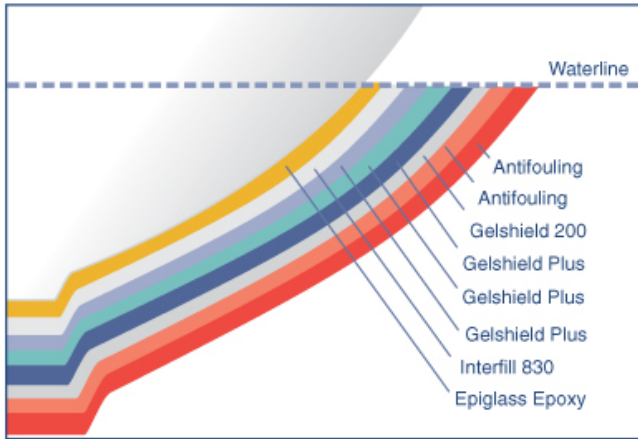
**Gelshield Plus (Blue) @ 150 microns**

**Gelshield Plus (Green) @ 150 microns**

**Gelshield Plus (Blue) @ 150 microns**

**Gelshield 200** grey as an antifouling tie coat @ 50 or 135 microns DFT depending on type of application e.g. roller or airless spray

**2 coats International Antifouling**



**Gelshield Plus used in conjunction with Epiglass:-**

**Epiglass Epoxy @ ~100 microns**

**Interfill 830 as required**

**Gelshield Plus (Blue) @ 150 microns**

**Gelshield Plus (Green) @ 150 microns**

**Gelshield Plus (Blue) @ 150 microns**

**Gelshield 200 grey as an antifouling tie coat @ 50 or 135 microns DFT depending on type of application e.g. roller or airless spray**

**2 coats International Antifouling**



Gelshield Plus blue: roller application



Gelshield Plus blue : tip-off by brush

## **Option 3 – Re-lamination and Treatment System**

### **Description of System**

#### **Epiglass Resins as Repair Systems**

Where laminates are physically damaged, **Epiglass HT9000 (YAA900 series)** epoxy resin is supplied as Standard cure, Slow cure or Fast cure have a role to play. **Epiglass HT9000** is a versatile epoxy resin system with a wide variety of uses the most common of which are sheathing and lamination, although given its versatility it also gets used for gluing, filling and fairing. Epiglass Epoxy is extremely water resistant.

#### **Repairing Holes in Laminates**

When the blister damage is particularly severe, there may be a hole right through the hull laminate. Damaged laminates are often repaired by what is commonly called the “pyramid system”. In this method the damaged area is cut back into a series of steps to enlarge the surface area to which the repair will be attached. The appearance therefore is that of a pyramid. Resin and woven roving is progressively built up in the repair area onto a backing board covered with a polythene sheet, held against the inside of the hull. The board is removed once the repair is completed. This system provides strong repairs suitable for overcoating with the **Gelshield Plus** system. This method of repair is widely used both in the yachting industry and in commercial areas.

#### **Rebuilding laminates**

Where some of the laminate thickness has been removed it will be necessary to rebuild most of the thickness to ensure hull strength is maintained. Epoxy laminates are stronger than those made with polyester as they do not contain any chopped strand glass matt. However, if the thickness is significantly less than the original, the stiffness of the hull panels will be lower.

Epiglass epoxy has very good fibre wet out properties and so thicker glass cloths can be used than might otherwise be possible. This will reduce working time and labour costs. Glass fabrics with a weight up to 1200g/sqm will be quite appropriate for this purpose. Multi-axial types, where a stitching process holds the fibres together, are preferred as they give stronger laminates and will conform more readily to the hull shape.

To help the heavier cloths ‘stick’ to the hull when the application is done ‘right way up’, a priming coat of Epiglass resin, thickened with Glue Powder, should be applied to the hull prior to the pre-wet out cloth.

A peel-ply applied over the re-laminated areas will serve two functions:-

**Laminate layers can be held tight against the hull if the peel-ply is used like a sling under the hull and tapes to the topsides.**

**Once cured, the peel-ply can be left on as a protective layer prior to being removed when the Gelshield Plus application is due to commence. Once removed the surface is both clean and textured, removing the need for any labour cost associated with cleaning or sanding.**

#### **Overcoating with Gelshield Plus**

Once the laminate has been rebuilt or repaired with Epiglass epoxy, Gelshield Plus can be applied direct during the ‘tacky’ period. In conditions that are cold or damp, there is a risk that an amine blush or bloom may form on the surface. This also seems ‘tacky’ and if it is not removed prior to overcoating, blister formation and de-lamination of the barrier system may result. A scrub down of the cured laminate with soapy water will remove this and once the surface is dry it can then be sanded in preparation for overcoating. This work can be avoided by using a peel-ply.

Should you require more data contact your local International Technical Representative to obtain a copy of the Epiglass Application Guide.

## Expectations of Success

Osmosis in GRP/FRP has been compared to rust for steel, always a threat where water is present. Consequently it is important to understand that combating osmosis is an on-going effort rather than a one-step solution although in the vast majority of instances success is achieved by following the procedures outlined in this section. Given the many and varied causes and contributory factors associated with osmosis in GRP yachts, and the fact that International Coatings has no control over actual application methods and conditions, it is not realistic to make any clearly defined commitment regarding the success or longevity of any treatment employing **Gelshield Plus**.

In all cases where a thick epoxy barrier coat has been applied, the moisture in the laminate will be lower than if the work had not been done. Low water permeation means less risk of osmosis. Many owners report that with a protecting system applied, the 'osmosis-free' life of a vessel is more than doubled.

For treatment cases the vessel should have an osmosis-free service period of about one to one and a half times the length of time before osmosis originally began.

There are two particular classes of "osmotic yacht" which are difficult to treat and where success is not expected: -

**Yachts under three years old: These hulls will be found to have reactive impurities or substantial structural defects, and should be referred to the builders. Treatment may prove effective for a limited period but substantial remedial treatment with an epoxy is probably required.**

**Repeated occurrences: Now that GRP/FRP has been used as a boat building material for many years, there are a number of yachts that have been treated for osmosis two or three times. Since the nature of osmosis is such that the polyester resin is broken down and dissolved reducing the integrity of the laminate, there is a high probability of a serious loss of strength in such hulls. It is probable that the standard Gelshield Plus specification for osmosis would be inadequate and will not enhance the overall strength of the hull. It is advisable in these situations to consult a Marine Surveyor.**

**An epoxy coating system is a very effective moisture barrier, however this also applies to impurities in the laminate not removed as part of the preparation regime. Once the yacht is back in service, moisture re-entering the hull, normally via the bilges may react with these forming compounds that cannot pass through the epoxy barrier. Blistering between coating and the hull may be the result of this action.**



## Conclusions

All Yachts that are well built with high-quality materials and good workmanship are likely to perform in a completely satisfactory manner for many years.

There are many reasons why gelcoat blistering can occur. The causes and contributory factors have now been analysed and are well understood. Nearly all osmosis-related problems arise from the presence of water in the laminate. The water itself can appear from a number of sources: -

**It may be present as an impurity in the resin.**

**It may have penetrated a gelcoat over a period of time.**

**It may have been drawn in from the bilges.**

In many cases, the water will have reacted with the emulsion binder or other impurities in the laminate, building up pressure and causing blistering.

The Gelshield system is a comprehensive approach to treating or protecting against osmosis

If the gelcoat of an affected yacht is removed and the hull allowed to dry out completely, coating the hull with **Gelshield Plus** will, in all probability, extend the useful life of the hull by many years. Similarly, applying a protection coating to an unaffected hull will extend the osmosis free life of any GRP/FRP vessel, whilst in severe cases, recommending **Epiglass** epoxy resin can make the hull as good as new and stronger than before.

### Disclaimer

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## **Precautions - Health & Safety**

All of the products sold by International for use in the **Gelshield Plus** coatings system contain chemical compounds that can damage the health of someone using them without the proper safety equipment. Adequate protection from any product only comes from inhibiting the ingestion of these chemicals, whether it is through the mouth, lungs, skin, or mucous membranes.

One of the more obvious rules is to never drink or eat any these products in their cured or uncured states.

***THESE PRODUCTS ARE FOR PROFESSIONAL USE ONLY***

***KEEP OUT OF REACH OF CHILDREN***

To protect against absorption through the skin, wear disposable paint suits with hoods, apply suitable barrier cream to hands and face, and wear gloves and masks whenever you are exposed to any of these products. Never clean antifouling paint or epoxy off your skin with solvents. There are many excellent hand cleaners on the market.

If at any time you experience dizziness, nausea, dullness, numbness, feel intoxicated, or have difficulty breathing during the application of these products or shortly thereafter, consult a doctor immediately and if possible show him the MSDS sheets of the products that you were exposed to. **Material Safety Data Sheets** are available by calling your local International Technical Representative.

Some of the materials listed in this Application Guide contain solvents that can ignite and burn or explode in the presence of a flame or spark. **Never smoke near an open or closed can of paint.**

***Gelshield Plus***

***Gelshield 200***

***Interprotect***

***Interfill 830 (standard and fast cure versions)***

***Interfill 833 (standard and fast cure versions)***

***Epiglass HT9000 ( slow, standard and fast cure versions)***

***Micron 55***