Failed Blister Repairs

A Case History and Solutions

by David Pascoe

John Williams is the proud owner of a ten year old 35' sloop. Prior to his purchase, he spent nearly a year searching around the country to find this particular yacht because it ideally suited his needs. When the survey was conducted, there was only one significant problem with it: it had a scattering of small blisters on the bottom, which I usually refer to as "pimple rash" to differentiate this condition from considerably larger blisters. The blisters in this case were no larger that 1/4" in diameter and had a density of about 2-3 blisters per square foot if averaged over the entire bottom area.

John lived in California and eventually moved to boat from these cool waters to Florida. Suddenly the 90º waters of Florida's waterways caused the number of blisters the number of blisters to blossom from perhaps a few hundred to several thousand. Not liking what he saw, he decided to have them repaired. Obtaining three estimates on the cost, he finally settled on the Ace Boatyard, in part because they used the West Epoxy system and Williams had heard that this material was highly successfull at solving the blistering problem. The cost was $7,000 and he was given a 5 year guarantee. He was also told that the repair would eliminate his blistering problem, although the yard manager did tell him that it was possible that "a few" blisters could possibly reappear.

The repair method included stripping off all the paint and old gelcoat with a specially designed machine by an outside contractor. This was followed by "fairing" and recoating the bottom according to the instructions provided by the manufacturers of the West System. In

addition, it also included "hot coating" the bottom, a method described to me as as applying the antifouling bottom paint to the bottom while the last coat of West System epoxy was still wet.

The job was completed, Mr. Williams paid his bill and went on his way, pleased that his blistering problem had now been repaired and solved. At least until a year later when the yacht was hauled and he discovered that about 50% of the blisters had reappeared. Returning to the yard that did the work, his complaint was greeted with a response somewhat different than what he was told prior to giving the yard his $7,000. Now the blister job was no longer a cure for the problem but simply a repair of the existing blisters. Moreover, all of the blisters that reappeared were new ones they said, unrelated to the ones just recently repaired. That meant that, although Ace Boatyard did indeed warrant that the blisters they repaired would stay fixed, the new blisters were not a reappearance of the old blisters, and therefore not covered by their 5 year warranty.

Mr. Williams estimated that about 1/3rd of all the blisters returned within one year, and he wasn't buying Ace's revision of their warranty. He was told that the repair would end his blistering problem, but it did not. The yard showed no sign of wanting to compromise the matter so he sued.

The yard's defense counsel hired a surveyor to look at the boat, and after doing so pronounced that the entire hull had severe delamination problems, determined by "sounding with a phenolic hammer." Nothing else was done to verify the "delamination." The yard then hung their defense on the premise of preexisting manufacturing defects as the reason why the repair wasn't successful and blisters recurred.

Called as experts for Mr. Williams, we examinated the yacht after the newly applied bottom coating had again been removed, the bottom being stripped down to the skin out mat and in some cases right down

to roving. Our sounding of the hull produced not the slightest indication of even possible delamination of the hull.

After removal of the newly applied barrier coatings, this is what Mr. Williams hull looked like. Knife blade is inserted into the void spot caused by the old blister. Most, if not all, of the original blister voids remained. At right, the new resin can be seen to have been applied directly over the old blisters.

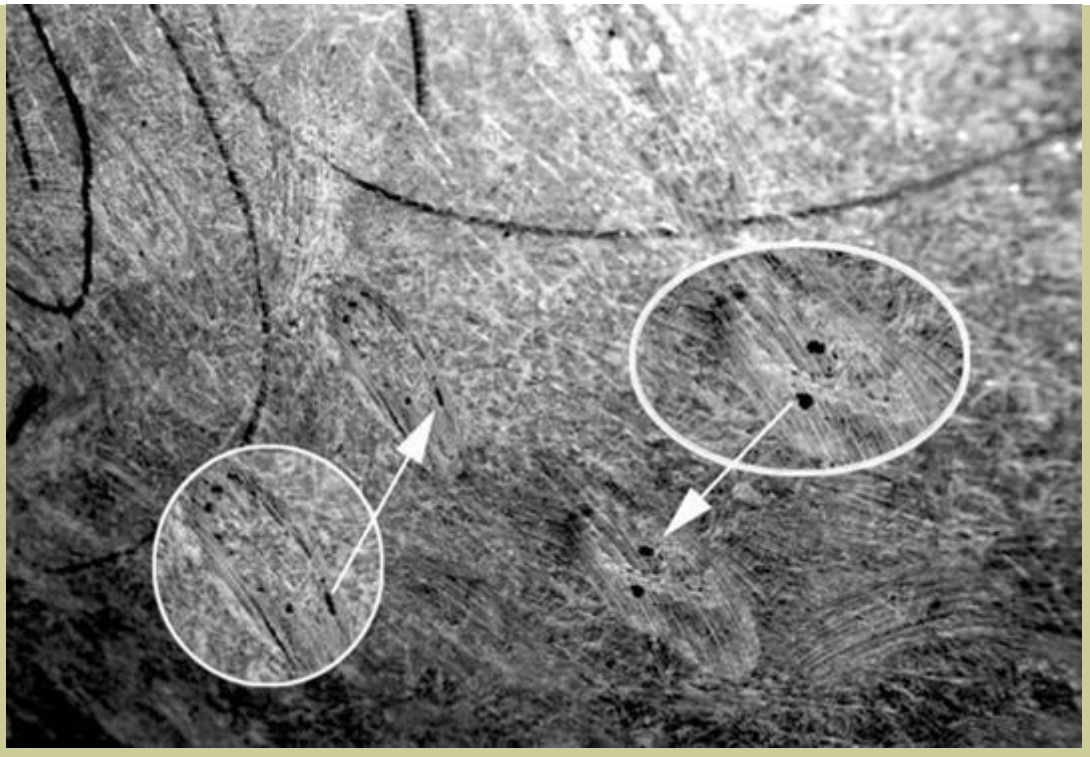
Note: The term "mat" or "skin out mat" refers to a fiberglass fabric made up of chopped fiberglass fibers that are quite short, usually about 3-4" long. These fibers are oriented in all directions and are not interwoven or interlocking, which is what mades the material relatively weak compared to woven fabrics. Mat is laid against the gel coat that is sprayed into the mold precisely because it does not have a weave pattern which would telegraph through the gel coat to give the hull finish the same texture as the fabric. The downside of its use is that it is very difficult for the laminators to make sure that the material is fully impregnated with plastic resin.

Multiple causes for the reappearance of the blisters became immediately apparent. These are as follows:

- As shown in nearby photos most, if not all, of the old blister cavities were still present. As far as we could determine, no effort was made to grind away the cavities or void areas and fill them.

- Scattered and random areas of the original skin out mat, as part of the original lay up, had significant areas of unsaturated fibers and minute voids, i.e. air bubbles in the original lay up.
- Some areas which had been faired with an unknown filler, but looks like two-part epoxy, were very soft and pliable, giving the appearance that it had not been mixed in proper ratios and did not cure properly. Since some of this material was hard, and some soft, we do not consider it likely that the material softened of its own accord.
- Judging by the coloration, it was apparent that two applications of a clear resin (although a few areas showed three) and one layer of a fairing material had been applied, the former by roller without being brushed out. In most areas where the barrier coating remained, it was usually found to be very thin, notably thinner than a typical gel coating. We estimate this at about 10 mils. A thick gel coat would be 30 mils, a thin one 20 mils.

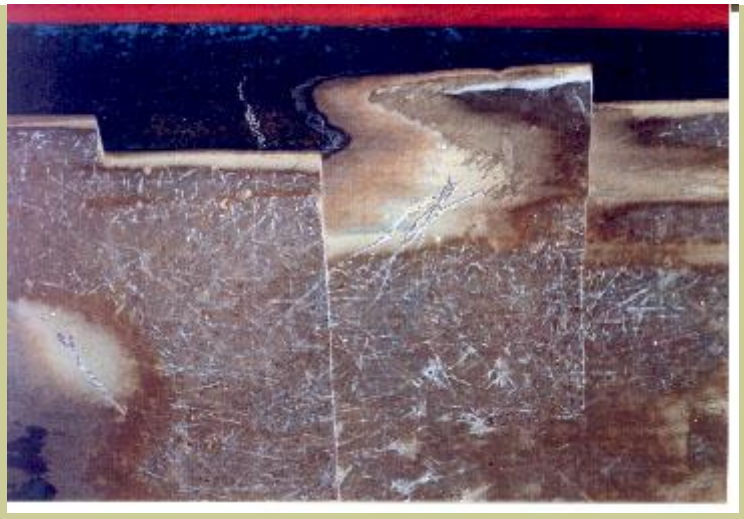
The failure to correct these imperfections provided the basis for the reformation of both the old and new blisters. Bearing in mind that the movement of the yacht from cool waters to the 90^{o} waters of the canals of Ft. Lauderdale resulted in a very rapid development of blisters, the yard had every reason to believe that the blistering of this hull was likely to continue at a rapid rate since Mr. Williams had explained all of this to them.



Although these blisters were ground away, the void spots or air bubbles within the skin out mat that initiated the blisters are clearly evident in this photo. The circled insets are enlarged for clarity. The polyester plastic here is not hydrolyzed (disolved) as some researchers claim is the cause of the problem. The plastic is hard and unaffected. If these voids are not removed, then the potential for reformation remains. Also note how dry some of the fibers are.

Assuming that the moisture meter used to determine that the hull had indeed dried out prior to recoating was accurate, this case, and many others like it, seem to belie the common notion that epoxy resins are significantly less permeable than polyesther. Otherwise, its difficult to explain why large numbers of blisters reappeared so rapidly. Either the hull was never really dry, or somehow it once again absorbed water.

Another shortcoming in the repair process was found, that being that the new coating had been applied with a paint roller and never leveled out. This left a surface texture that was quite rough, resulting in a surface mill thickness that was very irregular. Whether this had an affect on the reblistering hasn't been empirically determined, but if barrier coat thickness has anything to do with the rate of permeability, then its certainly reasonable to assume that it did.



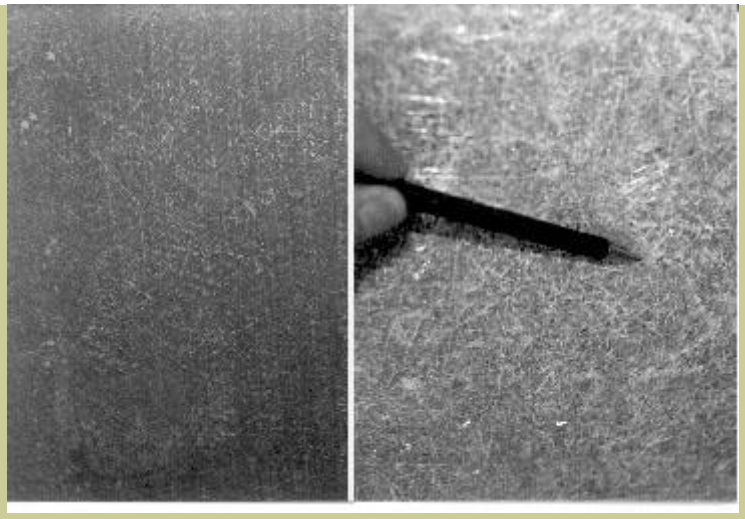
Fairing material that either turned soft or was not properly mixed and catalized. Scrape marks were made with the end of a ball point pen to indicate how soft is is, a perfect environment for blister formation. This is the poinit where the bottom was faired into the old gelcoat at the boot stripe. Note blister voids at lower center.

It also appears that a two-part epoxy filler was used in the fairing process that amounted to no more than 25% of the bottom area. This included spot filling depressions of what might have been larger blisters, as well as fairing around through hull fittings, fairing the waterline into the removed bottom gelcoat, as well as just general fairing. The fairing process was poorly accomplished, resulting in a "lumpy" appearance to the finished job. Most significantly, as we have found in a large number of other failed blister jobs, the fairing material, whatever it is, was found to be soft and pliable. Whether this resulted from improper mixing and incomplete curing, of if the material softened from water exposure or resultant chemical reactions, was not precisely determined. However, it would certainly be difficult to sand a filler that was not completely cured, and the fact of the lumpy appearance of the bottom suggests this possibility. On the other hand, our finding of so many other fillers that turn soft also suggests the likelihood of problems of (1) incompatibility of materials being combined, or (2) that these materials are severely affected by contact with sea water. All we can say for certain is that it is a two-part mix and that the material in many areas, although not all, was very soft.

A final flaw was discovered in that many of the blisters (we don't know what percentage because 90% of the bottom paint was removed) had occurred not under the new epoxy coating, but between the new coating and the new application of bottom paint. In other words, they were bottom paint blisters. And paint blisters are often misinterpreted as barrier coat blisters.

Since there was only one type and coating of bottom paint on the hull, this can't be attributed to incompatibility of bottom paints which, as we know, is usually the cause of paint blisters. So why would a brand new antifouling coat blister like this? Did it have something to do with the "hotcoating?" We would have to conclude that it must have, for there would seem to be no other explanation. Examination under magnification suggested a possible answer, since each blister that we dissected and examined revealed a pit, or indentation extending into the new epoxy barrier coat. The presence of the pit would suggest that a chemical reaction did indeed take place to cause the erosion that created the small pits and blisters in the paint.

Obviously, this begs the question of whether applying an antifouling coat to a wet epoxy barrier coat is a good idea. It may save the boat yard the task of sanding the bottom before painting, but it certainly didn't make the paint adhere any better.



Comparison view of fully saturated skin out mat at left, poorly saturated mat at right also showing numerous void spots or air

bubbles. Notice that no blisters appear in the fully saturated laminate. These two areas are the same boat hull. Doesn't this tell the real story of how and why blistering occurs? If the laminate is fully saturated, blisters CAN'T develop.

As we have stated in other articles, blister repair failures like these are becoming commonplace. One reason is due to the fact that there is such a great deal of misinformation floating around out there about the nature of the problem. Over the last decade, I have looked at thousands of blistered boat bottoms and I know one thing for certain. I have never seen blisters occurring in a laminate that did not have voids or unsaturated fibers. It can't happen because there must first be a void space of sufficient size to collect water in sufficient volume to initiate the blistering process. I am convinced that, lacking the voids, blisters cannot form.

The significance of this is twofold. First, for builders it means that if one ensures that there is a thorough wet out of the skin out mat, resulting in fully saturated fibers and minimal voids between gel coat and mat, and between mat and first structural layers, blisters will not form unless you are using third rate materials.

This photo, not this essay's subject vessel, shows a boat bottom with at least two dozen grind spots in little more than one square foot area. Despite all the grinding, hundreds of voids and areas of unsaturated fibers remain. When the condition of the skin out mat is this bad, it cannot be successfully repaired. It must be removed completely.

Unfortunately for the owner, the yard simply filled the holes and recoated it, with a high probability that the repair will fail.

Secondly, the same point applies to repairs. The uncorrected problems associated with Mr. William's failed blister repair are common to nearly all others. If the repairer eliminates the voids that help initiate the problem in the first place, he eliminates most of the potential for recurrance. Most repairers are knowledgeable enough to know that they have to remove the existing blister voids, and do so. Yet from touring boat yards and watching their process, it is clear that most are not dealing with the problem of poorly saturated fibers from the original construction. Recoating over a pooly saturated skin out mat occurs again and again.

This presents the repairer with something of a problem because to eliminate the unsaturated fibers in the skin out would mean that a lot of it has to be stripped away and replaced. The problem here is that this would significantly increase the cost to the customer that is likely to meet with resistance. There is a solution to this that will be explained further on.

While there is a great deal of myth about blisters, we have learned so far that:

- The vast majority of blisters occur between the skin out and the gel coat.
- A slightly smaller percentage occur within the skin out mat, or between the skin out and the first structural laminate.
- Blisters occurring within the structural laminate, particularly woven fibers, are extremely rare.
- Hydrolysis, or dissolution of the plastic, is not an initiator, but a secondary reaction of water in the laminate. Softening of the plastic does not usually occur until blistering is well advanced, and often doesn't occur at all.

There are a number of factors involved in why this is so:

- 1. Chopped strand mat is difficult to fully saturate and a very high percentage of all boats have unsaturated mat. That some do not blister suggests the use of far less permeable gelcoats and resins, or that some resins are more chemically stable than others.
- 2. The formation of blisters is associated with the softening of the barrier coat due to the presence of precipitated solvents from the resin (styrene) in a void space, and the build up of slight gas pressure sufficient to form the blister. But the pressure build up has been found to be very weak, so that the deformation of the blister may be less due to pressure than the effect of expansion of the gel coat caused by solvent softening. The mechanism is much the same as pouring acetone on cured paint, causing it to wrinkle.
- 3. Blisters do not form in the structural laminates if only because these heavy fibers are too strong to permit deformation of the laminate. On the other hand, gel coats and barrier coats are not fiber reinforced and are thus far more prone to surface deformation. For a blister to develop from a tiny air bubble between layers of roving, for example, would require a very high pressure indeed to result in deformation. On the other hand, random directional mat fibers are quite weak.
- 4. These points lead to the seemingly inescapable conclusion that poor saturation of skin out mat has to play a pivotal role in blister formation. If anyone has any doubts about this, try taking a tour through the boat yards and see if you can find blisters occurring within thoroughly saturated laminates. I can tell you in advance that you won't.

It is reasonable to conclude from this that, while epoxy and vinylesther resins are still sufficiently permeable to fail to prevent blistering, the elimination of most of the unsaturated fibers in the skin out mat will preclude most of their reformation when combined with higher quality resins.

It is foolish for a boat yard to give a 100% guarantee on blister repairs, for it is not possible to eliminate all voids close to the surface. Yet it is possible to remove 90% of the voids through careful preparation. Bear in mind that if it requires completely stripping the skin out mat, then there's no reason not to do so. It doesn't have to be put back on since the only reason for it's presence is to prevent telegraphing of roving pattern to the gelcoat, and that's not a consideration on the bottom of a hull. If the structural layers prove to be well-saturated, as they usually are, then the problem is going to be 90% solved.

Here is a particularly good shot of unsaturated fibers in a skin out mat. These really stand out because the layup resin in this hull is tinted dark blue. In most cases, the poorly saturated fibers do not stand out this well. In this case, as in so many others, the repairer simply applied a new barrier coat on top of this mess and the blisters reappeared with six months.

The bottom line to blister repairs is that there are far too many people in the business who don't know what they're doing. They apparently are not aware that for the repair to be successful, they must eliminate the defects that caused the blisters in the first place. Yet it is not possible to determine all of the factors that cause blistering, especially the cause of water getting into the laminate. The buzzword is "osmosis," as if permeability of coatings is the only means of water saturation. The reality is that we can identify a half-dozen ways that water can get into a laminate that have nothing to do with exterior coatings. So even if there were a totally effective, non-permeable coating, it would not solve the problem, for you can't prevent the

absorption of water from the interior of the hull, or around through hull fittings and so on.

But the one method that offers the greatest possibility of a cure is to eliminate the voids within the outer laminations where blisters commonly form. And if that means stripping the chopped strand mat from the hull, then that is what has to be done. Otherwise, its just money down the drain.

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Blister Repairs Part II

The Alchemist Still Hasn't Found the Philosopher's Stone

by David Pascoe

Over the course of the last several months it almost seems that I've been under siege by used boats with failed blister repair problems, some of which are illustrated by the photos below. Reading the magazines and surfing around the web, you probably get the impression, as I have, that the blister problem is abating. But taking a tour of the boat yards I come away with an altogether different impression: the problem is now worse than ever. Much . And so is the problem with the failure of repair efforts.

During the survey, I'm usually asked by my customer for an interpretation of what we see on the bottom after its hauled. These photos show why its impossible for me to answer the question; there's no way of knowing what's under the bottom paint until you start removing it. As often as not, what we find is an accumulation of years worth of hap-harzard attempts at repair. What we see here is akin to kids trying to do autobody work on their cars with no knowledge about

what they are doing. The methods and materials being applied are just a bit of anything and everything.

It is true, of course, that blister repair is now big business for boat yards. With repair costs typically running in the $4,000 - $7,000 range for small boats, for those yards that promote the business, its something of a bonanza for them. Even more so for the manufacturers of materials who are now doing a land office business selling their chemical prescriptions. But from what I can see in just looking around the yards, its clear that more than 50% of the repair work that I see in yards is on a do-it-yourself basis. And what is being done is only making a bad situation worse.

Another failed repair job. This one looks like the so-called "hot coating" where the bottom paint is applied over a wet barrier coat. At left are two larger blisters to which a grinder was applied. The skin out mat layer is plainly evident, is around 3/16" thick and is completely opaque, in addition to having a faulty bonding surface to the structural layers. Under the white layer, which you might think to be gel coat, is a black layer. We can't even imagine what that might be. What has been done to the bottom of this boat over the years (it is 15 years old) is beyond even guessing, but the one thing that is certain is that it there is no hope of successfully repairing it, even though the owner is

going to try again. Applying a new coating over this mess is like painting over dirt.

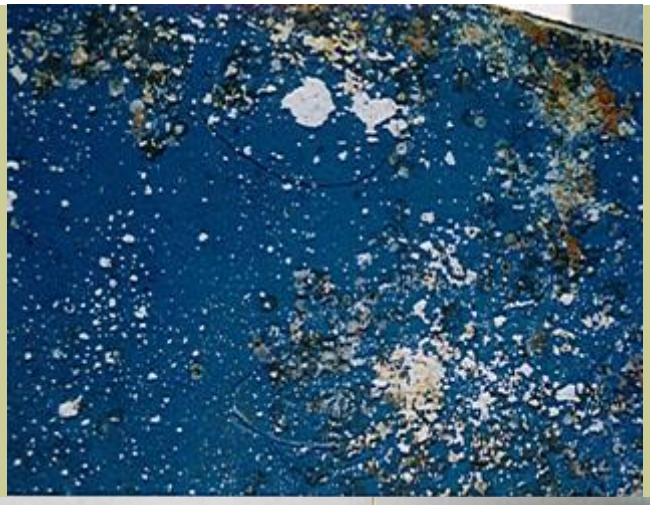
Which leads me to the subject of this essay, the growing problem of failed blister repairs. In the last two months, more than half of the boats we have surveyed that have blister problems involving failed repairs. The owners who were selling these boats, as one might expect, were less than forthcoming about what had been done to their bottoms. In fact, NOT ONE was willing to explain to me the procedure or materials that were used. Many feigned ignorance that anything was done at all, even though it was plainly evident by the number of coats of paint on the bottom (which are easy to count) that the repairs had taken place within a year or two. (A 10 year old boat with only one coat of paint and lots of grinder marks on the bottom tends to get my attention.) Clearly they were upset that whatever had been done wasn't working.

Doing it yourself can save a lot of money, at least initially. But it can present a big problem for the seller and the buyer a little further down the road: Many of the failed blister repairs we've seen over the last 60 days involved not complete recoating of the bottom, but spot or patch up repairs. Several more involved applying "barrier coats" over improperly prepared substrates. Naturally, we cannot completely reconstruct what was done short of doing a lot of probing to the underlying surfaces. But all we have to do is watch what is being done to so many of the other boats in the very same yards in which we are doing the surveys, to see what the nature of the problem is.

To make a long story short, its amateur repairs, or repairs by commercial yards who don't know what they're doing. Its people attacking boat bottoms with grinders and sandblasters and God knows what other kind of devices (sometimes even torches) and causing more damage than they are fixing. Its people applying an apparently endless variety of glop and goop to the bottom of these hulls in the name of "fixing it." But what they are really doing is just making a

bad situation worse. They are grinding and sanding and filling and painting and trowling and brushing, patching up the bottoms of their boats with a variety of materials whose colors span most of the spectrum. There is no consistency in what any of them are doing; they use different methods and different materials. We even saw, in a number of cases, boat owners applying fillers and barrier coats directly on top of antifouling paint.

What we are finding on our surveys comports with what we see boat owners doing. They are applying a hodge podge of materials to the bottoms, often year after year, to the point where the boat bottom becomes a veritable chemical stew. I use that phrase "chemical stew" intentionally because what is happening is that the morass of materials being applied to boat bottoms are reacting chemically and erupting into boiling cauldrons of alchemy. Its getting to the point where I don't want to touch a bottom without latex gloves on my hands.



Top: What you see here may look like gel coat blisters but actually the white spots are a chemical reaction between a variety of gunk that was smeared on the hull. There was almost no gel coat left.
Below: This is what it looked like after some kind of machine was used on the bottom. Here we can count four different kinds of filler, in addition to the black stuff that is now being applied on top of all the others, another patch up job. After he's done, he is going to seal all this mess over with a barrier coat. This owner's efforts are a complete waste of time and money.

One boat I looked at recently was the real clincher. There was only one coat of anti fouling paint on the bottom, which indicated that whatever had been done most recently was probably only a year ago. Cutting into some of the bottom layers, I found six different colored materials under the antifouling. SIX! In some areas material had been applied over the antifouling. And it was clear, by this variety of multicolored materials, that blister repair had been an on-going patch

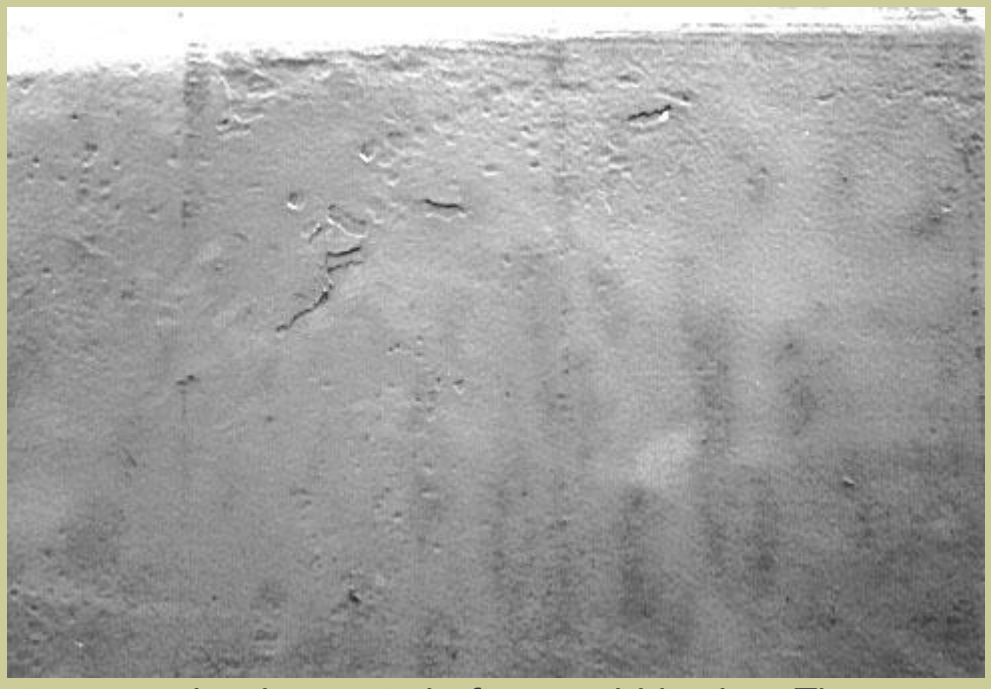
up process. The fact that the bottom had broken out, not in thousands, but millions of tiny blisters on the surface, just under the paint, is what caught my attention. But what held my attention was that these bottom coatings had turned to mush. Virtually all of the materials applied to the bottom were as soft as day-old paint. Moreover, the stuff was saturated with water and styrene, which has a strong vinegar-like smell. Pick any spot on the bottom and prick it with a sharp knife and this styrene based fluid would start to seep out. Anywhere.

What's happening here is that boat owners are reading stuff in magazines and on the web and then attempting to repair the blisters themselves, either taking advice from people who don't know what they're talking about, or they're just winging it. Whatever the case, they're just making a bad situation worse. Often much worse. They would have been much better off had they just left well enough alone. For instead of blisters, what they end up with is a festering wound.

While there's no way for us to know exactly what's been done and why it went wrong, I have found some common factors.

- The bottom had been sandblasted, attacked with a grinder, or some other method employed that eroded the gelcoat, leaving a pock-marked surface like the face of the moon.
- Materials were used that were either incompatible or inappropriate, particularly fillers or fairing material.
- The materials hawked as being water resistant are not styrene or acid resistant, and were softened or partially dissolved.
- Heavy layers of poorly saturated chopped strand mat continues to be one of the predominant factors in both initial and secondary blistering. The worst cases invariably involve heavy layers of mat on the exterior, as revealed in the top right photo where two ground out blisters reveal a mat nearly 1/4" thick.

The effects of rotary pressure stripping. This process does not remove the gel coat but merely errodes it, leaving it in worse condition than ever. A barrier coating applied to a surface like this is an exercise in futility and a waste of money. This is not the first time around for this boat: notice the prior repaired area at right. This is the third time around for this boat.



This bottom was barrier coated after sand blasting. The craters in the gel coat still remain and the surface is now more porous than ever. The blisters returned with a vengence. They didn't even bother to fair out the craters. Unfortunately, this kind of repair work has become common.

Advice for Buyers

Once a blister repair job has been botched, it only gets worse from there. For now the owner has introduced a witches' brew of new chemicals into the equation with all the additional layers he's added. Even worse, he's probably made the hull more porous than it was before, meaning that the poorly saturated mat is going to absorb water faster than ever. There's no way what you see illustrated in these photos can be "sealed." Its like trying to seal a sponge. At this point, the only thing left to do is to strip the entire bottom right down to the structural laminate, which is what should have been done in the first place.

The problem that this poses for the used boat buyer is that the botched repair job is far worse than a boat that merely has blisters. This is not the kind of situation that you want to buy into; in many cases, the botched repair job now will no longer even hold antifouling paint on the bottom because it, too, is reacting chemically and bubbling off. And if you can't keep the bottom paint on, you really do have a problem, one that's a lot worse than just blisters.

This situation is becoming so commonplace that the best advice we can give used boat buyers is to not even consider buying such a boat. And you might just as well inform the broker or seller in advance, before you go the trouble of signing a contract and getting a survey, that you will reject the boat if it has a failed repair job. You should also be aware that the boats built in the orient are the absolute worst for these kinds of problems, with many of the other imports following as close seconds. Moreover, there is a direct correlation to the amount of chopped strand mat on the exterior and where it was built. Its not unusual to find Chinese boats where the mat is 1/4" thick and over. We are happy to report that the incidence of severe blistering with US built boats is considerably less, although far from non existant.

Is There a Right Way?

The first thing you have to understand (and accept) is that some boats are not repairable. That's because the quality of materials and workmanship used to build the boat is so bad that what you have is an unstable hull laminate. Adding a barrier coating is not going to prevent the chemical reactions from continuing to occur. You can coat the bottom, but its going to absorb water above the water line and from the interior.

The relationship between boats with severe blistering and boats with excessive chopped strand mat on the exterior can be proven beyond any reasonable doubt. So, too is the problem of hulls where the gel coat is not thoroughly bonded to the mat. Add to that the fact that blisters always occur under the gel coat or with the mat, but almost never within the structural laminates (such as roving or other woven fabrics), and we know for certain that the problem lies within these two outer layers. It stands to reason, then, that if it is possible to remove these offending materials, its is possible to solve the problem. Unfortunately, if the hull has 1/4" of chopped strand mat on the exterior, that mat comprises so much of the thickness of the hull that removing it means removing half the hull. If that's the case, then removing it is no longer an option, so that the hull is then essentially unrepairable.

If the mat layer is thin, say 1/8" - 3/16" then it can be removed without significantly reducing the hull thickness. Of course, there is always the option of stripping a heavy mat layer, and relaminating with a heavy fabric, bearing in mind that fabrics are too strong to allow blisters to form. But that would be rather costly.

We draw a distinction between a bottom that had thousands of pimples and those that have larger blisters. Pimpling is a different phenomenon than a hull that develops just a few larger blisters. While we do not know what the cause is, we can say that it is often associated with solvent softening of the gelcoat. In many cases of

pimpling we find the gel coat to be soft and pliable. With larger blisters the gel coat is usually brittle.

Boats with a relatively small number of larger blisters (1" for example) are amenable to spot repairs, which are often successful. If the bottom of your boat has, say, 100 blisters on the bottom, we would recommend spot repairs over stripping and recoating the bottom. We would not recommend barrier coating after spot repairs. Spot repairs are inexpensive, and if they do fail, at least you won't be out a lot of money.

Repair Tips

We continue to recommend that the best way to solve the problem of extensive blistering is with complete removal of the chopped strand mat. This material is the primary source of the problem. The most badly blistered boats continue to be those with heavy external layers of mat, and it is our opinion that the blistering cannot be stopped until the material is removed.

- Under no circumstances should you ever sand blast or sand sweep a bottom. Sandblasting shatters the plastic and exposes the fibers far more than they already are. In addition, it craters the gel coat with millions of craters that only worsens the problem when it is sand swept.
- Virtually the same result occurs when these rotary water pressure strippers are used. The end result is as bad as sandblasting. It pocks the gel coat and shreds the exposed fiber bundles, opening up more channels for water ingress.
- The recommended method for removal of gel coat and mat is the planing machine with carbide cutters. This machine will cut off gel coat and mat with minimal damage to the plastic or shredding of the fiber bundles, leaving a clean, smooth surface suitable for recoating. Yes, its more expensive, but it does the job right.
- For spot repairing blisters, we recommend the use of two part epoxy paste ONLY. Do NOT use microballons or fairing material of any kind.

You should purchase only the highest quality epoxy, which means the most expensive, and usually one with a recognizable name brand.

- If you do not know how to use a grinder to grind out blisters, DO NOT DO IT. Either learn how or get some one who does. The odds are very high that you will only make matters worse. This is not a job for amatuers. Very few professional yards even know how to do it right.
- Before considering whether to engage a yard to make repairs, determine how thick the skin out mat is. If it is more than 1/8" the odds of success are slim. You will be applying your epoxy or vinylester on top of a sponge.
- Determine how porous the mat is. The better the saturation of the mat with resin, the higher the odds of success. The mat should appear translucent, NOT OPAQUE. If it is opaque or whitish looking, the chance of success if slim. If the mat shows numerous small voids, these are the propagation points for new blisters and the repair is likely to fail.
- If you see blister voids deep within the mat (small, round, opaque areas), the mat has to come off. Coat over this kind of surface and the blisters will come right back again.
- If you are unwilling to pay the cost of stripping off heavy layers of mat, consider whether the blister repair is really necessary. You may be better off just leaving it alone.

Finally, the situation has become so severe that we can only counsel against buying a boat with a botched blister repair job. The ulcers on the bottom of the boat are likely to end up in your stomach.

Here's a 22 year old Bertram with about 100 blisters on the bottom. It has never had any kind of repairs. Is it worth tearing up the bottom and risking making the situation worse? Or would the owner just be better off leaving it alone? We'd opt for the later.

About Barrier Coating

The idea of barrier coating is to replace porous gel coat with a more water resistent material such as vinylester or epoxy resin. In theory, its a good idea; in reality it doesn't always work out that way, for the problem is WHAT you are applying that coating to, and whether the coating can be made thick enough to really keep the water out.

For some answers we looked to Hatteras Yachts which, as many of us know, has had enormous blistering problems in the past, and which dealt with it by repairing many of their boats under warranty. So we started wondering how did those repairs hold up? As near as we can tell, by checking on the number of boats built in the 1980's, the answer is fairly well. Its very easy to determine whether a hull has been repaired just by scratching the surface to see if there's gel coat under the paint. If not, then you know its been recoated. The number of Hatterases we see with reemerging blisters is very few. But bear in mind that these are very expensive, larger yachts (50, 60, 70 footers) where the job was probably done right. Usually with the outer

layers being removed by hand grinding. The other factor we see is that these coatings are usually quite thick and don't involve any fairing material (like microballons) at all. In other words, the repair is a combination of epoxy paste filler and epoxy or vinylester coating. And nothing else.

The chopped strand substrate on a Hatteras is usually quite thick and porous, but when we see the jobs done at yards like Derector-Gunnell and other high end yards, (I'm talking here over a period of a decade or more) we usually see most of the mat removed and the roving showing through in many places. For the most part, these repair jobs are either completely successful, or fail completely. Very rarely do we see reemergence of only a few blisters. Contrast this with the massive failures that are found on smaller boats. Obviously, with high the cost of a repair job on a million dollar yacht, there is considerable motivation to do it right, as the cost of failure could seriously hurt a yard.

Considering these factors, its hard not to draw some conclusions about the relationship between the dollar value of the repair versus the success rate. The bigger the yacht, the greater the success rate. So what's going on here? Is barrier coating working? Or when it fails, why does it fail? Well, I think the answer has already been given in what has been said so far. The answer is in knowing what works, and the knowledge of how to do it right. But ultimately that boils down to an issue of COST. Successful blister repair is expensive. Barrier coating only works up to a point. That point is predicated on applying the coating to a surface that is not highly porous, such as with a heavy layer of mat. Barrier coatings are not completely water proof, nor can all the water in the hull laminate be eliminated, or prevented from returning. Water can be absorbed from above the water line, and from the hull interior. To be successful, the voids where blisters propagate have to be eliminated. And that usually means removing the chopped strand mat.

Why Are There No Absolute Answers?

I am often asked this question, but the answer is difficult to comprehend if you don't understand the nature of boat building. It goes back to the fact that boats are hand made items, usually by companies that are quite small and are sorely lacking in resources and production controls. One day they use this kind of material, the next day something else. In other words, most boat hulls are different, even among the same models by the same builder.

Because there are tens of thousands of different boats all built somewhat differently, no one has even bothered to attempt to study the problem. Besides, how could anyone go around chopping up peoples boat's to study the problem? Even if someone were willing to invest the millions that such a research study would require, the resulting answers would probably be very unsatisfying. It would likely end up with dozens of explanations and mitigating factors that would leave us just as confused as ever. In fact, some of the chemical companies have done some in-house research, including the one I was involved with back in the early 1980's (Uniflite). While I never saw the entire results of that research, I do know that a large number of factors were identified, far more than are common knowledge today. If a complete dissertation on the subject were published, it would be so complex that no one would want to read it. It would just make your head swim with possibilities. It may be just as well that that research, utilized in the Uniflite class action lawsuit, was ultimately sealed in the court settlement, never to be revealed.

The only thing we know for sure is that it is quite possible to build boats that don't blister by using quality materials and methods. As long as the boating public is willing to foot the bill for this terribly expensive problem, without holding the builders feet to the fire, then we'll just have to suffer with it.