The UNSW Solar Racing Team Mold Release Handbook

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1 Preface

This document was originally prepared in June 2004 while I was a member of the UNSW Solar Racing Team working on tooling for Sunswift III. I've chosen to update it, proofread, and make it available on my web page for those curious about using Zyvax as a release agent. This document is provided "as is" for the benefit of the reader. I am not an expert in fiberglass tooling or release agents, but I did have a fair bit of success with the procedures outlined below while working on the solar car. I hope others can benefit from this knowledge. If you have any questions, you can email them to glinder@linderlabs.com, but it's probably better to talk to the folks at Zyvax (www.zyvax.com) if you really need help with tool release.

2 Introduction to mold release

First off, a caution- Fiberglass tools are a lot more gentle and fragile than they at first appear. They will break if dropped, and they scratch very easily. Any release coatings put on the inside of a tool are very fragile as well. Some of them will wash off even with water. If you ever do any work on a tool, make sure you check the release agent before laying up. Any sanding, cleaning with anything, or even harsh wiping might affect the release agent. There are many photos of various mold mistakes. The goal is to make mistakes as small as possible if they do occur. Avoid using acetone, methylated spirits, ethanol, and anything other than a soft rag and water for Zyvaxed tools. Anything else requires re-seasoning the tool, as it will remove the release agent. If the tool needs to be truly cleaned, then it most likely needs re-seasoning as well.

Whenever a part is made on a tool, eventually the part must be removed from the tool. This is what a mold release system does. It is a treatment done to the mold (otherwise known as a tooling surface, plug, template- Whatever you are making the new part off of) that allows the parts to be laid up and easily removed when cured.

There are three key ways to get parts off of tools:

1. Waxes- These go on just like car waxes, in multiple layers. Wax gets rubbed on, let sit for a bit, and then buffed off. It is fairly hard work, and takes a long time. It is of key importance to find a wax that is compatible with the surface of the tooling and the surface of the finished part. Different waxes work with different chemicals, and cooperate differently with different types of paint. Depending on surfaces used, and the manner in which the parts are physically separated, one of more layers of wax will have to be re-applied with each part.

2. PVA (polyvinylacetate)- This is a blue liquid that when wiped on dries to a thin cling-film like covering. The general idea of this is that it is wiped on fairly liberally to a smooth surface and let dry. Your part is laid up over the PVA, and when cured, is pulled off the tool, with or without the PVA coating. Because the PVA is water soluble, the part and tool are then washed with water, removing the blue film of the PVA. This also has some interesting incompatibilities, and does very strange things to different types of paints. It also does not work in shear particularly well, so it is not the right choice for parts with straight steep angles, as that is not peeling the PVA off as with a flat surface, but dragging over itself. PVA needs to be re-applied with each part, and also needs to be washed off the part before any further finishing.

3. Permanent / Semi-permanent release coatings- Frekote and Zyvax are both members of this family. These are semi-permanent coatings, meaning that they do not need to get re-applied after each part. They are fairly expensive, compared to the other two methods. Frekote is very toxic and highly unhealthy. The cans it comes in have all kinds of warnings about liver damage and fume inhalation and everything else. It also takes a long time to apply, due to the huge wait between coats. The Zyvax system, which is much safer, less dangerous, and more robust, is described in detail in this paper.

A word of warning about release chemicals: do not mix and match chemicals, ever. That is a bad idea, and leads to all sorts of funny things. If you are going to paint the surface, follow the instructions for the paint system that is being used, and use all the same brands. Never mix mold release agents, as there is a fairly high likelihood of bad things happening. Early attempts were made to do this, under the feeling that a layer of PVA over wax was better, and the wax and PVA reacted funny and turned into a sticky mess. If you do want to mix things, try it on a small part, like a popsicle stick stuck with epoxy to the tool, rather than covering the whole thing. Small mistakes are easier and less time consuming to fix than huge ones.

This requires that things be partially planned in advance. If you don't know if something will work, do not due in on an important piece and on a large scale. Chances are it will stuff up, and leave you having a huge mess to clean up.

3 The Zyvax mold release system

Zyvax is a company that makes many different release agents. When this document refers to the Zyvax system, it is referring to three products made by Zyvax designed to work together. It just picked up the name of "Zyvaxing the tool" in the local vernacular. This system consists of the following three products:

- Fresh Start
- SealerGP
- CompositeShield

The chemicals are fairly expensive, but can be used very sparingly- For example, at the time of writing, a one gallon (3.78 litre) can of SealerGP was AUD $377.00, with the CompositeShield being about the same cost.

This system has been used to successfully release the following:

1. Prepreg carbon parts (this system is Hawker de Havilland's part release system)
2. Polyurethane expanding foam parts
3. High-temp resin (HY-2954 / LY-568) parts
4. Low-temp resin (Renlam M) parts
5. Spray-bogged parts (when properly sealed)

It is quick compared to waxing, and guaranteed functional if applied correctly. Because the system uses three chemicals all tuned for one another, then there are no strange things that happen. Another benefit of this system is that you can see what the surface will look like as it goes on. If the products do not go as described in this manual, then perhaps the surface treatment (paint or whatever) is not compatible.

Personal Protective Gear is not required according to Zyvax, but follow the rules where the product is to be used. At Hawker de Havilland, they require the work to be done in the plastic booth thing with the vent fans running, using respirators. This is what the needed for the previous chemical, called Frekote. The Zyvax rep in Australia applied the stuff without even using gloves. So have I. The Zyvax family is relatively harmless and does not have much of an odor.

All three products in this Zyvax system are air sensitive. The air is what causes them to work. Therefore, do not leave cans of the stuff open and lying around. The chemicals will not work long after. If there is an open can of anything in a cabinet and no one remembers where it came from, test it out on a small patch before doing something big with it. Once it has been tested, if it does not work, get rid of it, or at the very least label it as "Does not work. Do not use". It is not possible to tell if any of the Zyvax products have "gone off" by scent, as they do not smell.

This procedure describes how to "season" a part such that it is ready to be used for the first time. If the mold has already been seasoned, and successfully released a part, then it is only necessary to apply one coat of CompositeShield over the tool, and lay up after half an hour. The only time this procedure is to be gone all the way through is when the tool is first prepped, or when it has been sanded, cleaned with any sort of chemical, or otherwise physically or chemically affected.

4 In The Beginning- Zyvax Fresh Start

Fresh Start is a cleaning chemical, designed to either clean a new mold or plug, or re-clean a tool that has had multiple parts taken off of it. It is water based, non toxic, and slightly gritty. It comes in a reflective squeeze bag, and is hard to get from our sponsorship with Boeing, as people tend to take it home to clean their barbecues and such. It is very important that the cap be replaced in the squeeze pack as soon as the chemical has been dispensed. Leaving it open over night will let the water evaporate off, leaving a solid block in the bottom of the bag, which is no good for cleaning plugs.

4.1 Using Fresh Start

Equipment required.

1. Fresh Start in little pouch. Ask at Hawkers well in advance to get some
2. Gloves wouldn't hurt

Freshstart, at a glance.

1. Get clean rag that is slightly moist- that is, one that has been soaked and wrung out good
2. Squirt fresh start on the surface of the tool
3. Add a small amount of extra water
4. Start washing
5. When clean, rinse off remaining grit with clean water.

Comments and notes on Fresh Start.

Fresh Start is a non toxic water based tool cleaner, designed to get all the oil and crud off of the tool surface to prepare it for the application of SealerGP and Compositeshield. It comes in a shiny plastic squeeze bag, and when dispensed is a slightly thick white paste.

To use fresh start, squirt it on with a little water, and start washing. By "A little water" that does not mean working in a puddle on the tool. The rag should be damp and wrung out. When working with spray bogged tools, use

real cloth, and not paper towels, to avoid leaving paper towel bits all over the surface. It is mildly abrasive, but not enough to cause damage to anything. As long as it foams up a bit, then it is still doing its job

It is of the utmost importance to not leave the cap off the fresh start. It will dry over night, leaving a block of grit in the bottom of a plastic bag, which is no good for cleaning tools.

If cleaning resin off of an old tool, the tool will be clean when it looks clean. All the brown left over resin will come off, along with the sealer beneath it. Whenever you clean a tool with anything other than water, it needs to be "re-seasoned", that is, have the SealerGP and Compositeshield re-applied.

5 And then, there was SealerGP

SealerGP is the surface sealer. It is supposed to go over a tool cleaned with Fresh Start. However, if Fresh Start is not available for whatever reason, make sure you have a clean good surface over which to apply it. Read the can of spray bog, and follow the directions. Some of them specify a degrease before putting coats of new material on, and others do not. Do what the can says. Oil on the surface of the tool will cause the SealerGP to not seal right, creating problems for the eventual release of the tool. Dirt, grit, etc will also cause problems. The right tool for the job is Fresh Start, but then we don't always have access to the right tools, do we?

When your surface is clean, ideally you will have a water break free surface. This means that if water is poured over the entire surface of the tool, it will settle into a glassy surface, or run cleanly off. Any breaks and rivulets that form in the water means that there is still bad surface beneath the water. Note that on some tools, a water break free surface will not be able to be achieved. If the surface of the tooling is pitted (i.e. with pinholes from a stuffed spray bog job), then you will never get a water break free surface. If you can't get a water break free surface, a really clean surface is good enough for small parts. When doing large things or where applying of excess force is not reasonable, a pinhole free and water break free surface is necessary.

5.1 Applying SealerGP

Equipment Required.

1. Can of SealerGP
2. Two clean rags
3. Time available at 15 minutes per coat

SealerGP, at a glance.

1. Unscrew the cap of the sealer, and hold the first clean rag over the nozzle, tipping it until a spot on the rag is just a little moist. Screw the cap back on immediately after use.

2. Wipe on the tool, making sure you wipe 90 degrees to the previous direction of wipe .

3. Wipe off immediately (less than one minute) with second rag after wiped on.

4. Wait 15 minutes

5. Repeat 1-4

6. When the needed number of coats is applied, wait at least 30 minutes until applying CompositeShield.

Comments and notes on SealerGP.

The sealer is a very nice chemical- You really do not need any PPE, according to the folks from Zyvax. Their rep, when he came, did not even use gloves.

SealerGP must be applied to a clean, dry tool. You need very little of it- When it says "wipe on, wipe off" it is not lying. You remove most of the material anyways, if you are sealing a good quality tool. Some plugs were laid up that had just spray bog that were not painted, and it took more than 8 coats of SealerGP before it stopped soaking into the surface. What you want is for the sealer to wipe on clean and shiny, so the part looks uniformly wet, and then wipe it off. If it wipes on and immediately becomes invisible, it means that your surface is really porous, and it needs a lot of sealer. In this case a different paint system should be explored.

For example, the number of coats of SealerGP to use on a good metal tool would be at least 4. For a fiberglass tool in good shape, i.e. smooth, happy surface, we would use at least 5. For a spray bogged tool that is just spray bog with no paint or anything, there should be at the very least 9. Use your eyes. If there are nine coats of SealerGP on the tool, and it is not wiping on and looking uniformly wet over the whole surface, then there still needs to be more sealer.

The Zyvax folks recommend wiping it on at 90 degrees to the previous wipe. This means that if there are any holes or whatever, that they will be filled from multiple directions with the sealer. Also, do not let the sealer go off before you wipe it off. The stuff goes on wet, but stars to dry immediately. This is also why you need to close the can immediately after use. Air causes the stuff to go off, and we do not want to ruin our chemicals. The Zyvax folks recommend that a tool be covered in smallish (easily arm reachable) sections, and then it be wiped off with the second rag. This way, you do not leave the chemical pooling on the surface. It does not matter if you overlap with a previous patch of applied sealer.

If the SealerGP does pool on the surface, it will go off and cause problems. I don't know what will happen if pooled sealer is allowed to set, but I am pretty sure it will not release properly.

You should use two rags for the SealerGP: One to wipe on, and one to wipe off. I got in the habit of putting the wipe-on rag on top of the closed can of SealerGP, and the wipe off rag on top of another clean rag next to the can.

Make sure the environment you apply it in is clean. Any grit that gets caught in your soft rags will damage the surface of the tool.

6 And finally, there was CompositeShield

Equipment required.

1. Clean tool that has been properly sealed
2. Container of CompositeShield
3. Two clean rags

CompositeShield, at a glance.

1. Unscrew the cap of the CompositeShield, and hold the first clean rag over the nozzle, tipping it until a spot on the rag is just a little moist. Screw the cap back on immediately after use.
2. Wipe on the tool, making sure you wipe 90 degrees to the previous direction of wipe .
3. Wipe off immediately (less than one minute) with second rag after wiped on.
4. Wait 15 minutes
5. Repeat 1-4
6. When the needed number of coats is applied, wait at least 30 minutes until starting any layup.

Comments and notes on CompositeShield.

CompositeShield is the final chemical to be used in the mold seasoning process. This is the part that actually forms the barrier between the tooling surface and the material to be laid up. It is applied in the same way as the SealerGP, and is hurt by the same stuff. So do not leave cans open for any longer than is absolutely necessary.

A good number of coats of CompositeShield for a nice metal tool is around 4 coats. With our fiberglass tools, the more the merrier. Good results can be expected with as few as 4 for a tool that is in good shape, but for the sake of not stuffing up, I have been using 6 layers of CompositeShield.

When applying this chemical, if it soaks in at all,then you stuffed up and did not seal enough. See the Mold making manual for details and photos of what happens when this occurs. It should wipe on with a wet look just like the sealer, and then be removed again. If, for some reason, this is put on and the surface has not been sealed properly, you cannot go back and put more sealer on. The SealerGP will not stick right to the CompositeShield. The only

option is to pull out the sandpaper and start sanding to get the sealer and CompositeShield off. It should be pretty apparent when applying the SealerGP if the CompositeShield will go on right or not, as the products are applied in exactly the same way.

After the CompositeShield has been finished, let the tool sit for about a half hour before layup starts. At this point, it should be good to go, and can take whatever needs to be done. When applying gel coats or early thin fiberglass weaves, be careful. The Zyvax system works well for getting the parts apart, but it scratches very easily. Also, once it has been applied, because the surface has different properties, epoxies will flow differently that on a non-finished tool.

If there is any doubt as to the quality of the release agent, test the coating as answered in the FAQ below. Not testing the release agent can be a big problem.

7 FAQ

7.1 Who do I talk to for questions or product?

There are a few different ways to get more product or questions answered:

1. For general information, use www.zyvax.com. Good web page, nice company.

2. Hawker de Havilland- See if anyone there can help us get more. They are very protective of their Fresh Start, as it apparently also works quite well on barbecue grills and things like that. They kindly donated a lot of stuff to us in the past.

3. Other phone numbers and contact information removed in 1/10/08 rewrite.

7.2 How many coats?

The folks at Hawker de Havilland (should) use four coats of SealerGP on a newly cleaned metal tool, followed by four coats of CompositeShield. Thereafter, the parts will release with a single new layer of CompositeShield applied before each part, until the next cleaning.

For our tooling, if we are doing spray bog and not painting or prepping beyond that, 8 coats of SealerGP is the minimum. The general rule is that at least four coats need to be applied after the product has stopped soaking in. After that, 4 or more coats of CompositeShield can be applied. If prepping a big, expensive plug (like the plugs for the car), it would be a good idea to test the release first before laying up the whole part. If in doubt, add more coats, but do not add SealerGP over CompositeShield. It will not work well.

7.3 What do I do if I put down CompositeShield and need more SealerGP?

The tool must be sanded back and the SealerGP re-applied. The SealerGP will not seal right after the CompositeShield has been put down. If the SealerGP is still soaking in, do not apply the CompositeShield.

7.4 What about painting the surface of the plug?

This is something that still needs to be researched a fair amount. We have not yet tried laying up on any painted surfaces, at the time of this writing, but we have had several successful releases from tools sealed only with spray bog. (Tight internal corners do not work well, however, and even in the good releases chunks of spray bog from the corners often come up in the tooling).

The best promise for this seems to be a company called Duratec (www.duratec1.com - the "1" isn't a mistake). Painting the tool is a good idea when using Zyvax, so long as you choose a compatible system, because it takes a lot of SealerGP to properly seal a spraybogged tool. The general goal is to use compatible chemicals (i.e. products from the same manufacturer designed to work together), and trying it out first and being sure it worked. Duratec makes chemicals specifically for treating plugs for toolmaking, and for this reason deserves to be investigated further.

At the current time, our tests with paints have been dismal. SealerGP was not soaking in, even after 11 coats, on a surface painted with metallic paint. The surface was also sprayed with an acrylic clear coat, although the quality of the clear coat and the age of the material were both suspect. Metallic paints are not recommended for Zyvax.

7.5 What's the best way to release the part?

Using a hammer. Believe it or not, with the Zyvax, the best way seems to be to hit the back of the mold. There is a big rubber mallet at Solarch, and a couple of nice, gentle whacks to the back of the mold seems to be enough to dislodge the part. You could also ram wedges into the seams, and things like that, but with the Zyvax all you need to do is break the surface tension and the part falls right out. The mallet seems to be a good way to do it. This method was discovered on Scott's suggestion when trying to release the first attempt made at a casting. Two wacks to the back of the low-temp mold, and the part fell right out. Brilliant.

The other way is using wood wedges pounded in at the seems of the mold, which works as well, but it is much cooler to demonstrate the "whack whack, thunk" type of release. Also, do NOT use metal at all to release the part. The main threat here is damaging the tooling or the parts. If you use hammers, be very careful. Chisels are a no-no unless you really know what you are doing, or else you risk stuffing up the mold and the plug.

7.6 What if something sticks?

Uh-oh. It's time to start panicking. If something sticks, and you absolutely have to get the part off the mold, or the plug out of the mold, then you have to destroy something. Usually this involves pounding in wood wedges, prying, crying, and making a mess. Make sure that the Zyvax is applied right, and this shouldn't be the problem.

There have been multiple occasions when things have really stuffed up that I know of. One required chipping out MDF (and a _lot_ of MDF) to get the mold complete, and one recently involved chipping expanding foam out of a mold. If something sticks, you just have to pry. Sometimes it is possible to save the tool, but it takes a lot of work, and can be very frustrating.

7.7 What is the proper way to pour the chemicals of the Zyvax system?

When using SealerGP and CompositeShield, do not just up end the can on the tooling surface. If you do, you are wasting material, and possibly stuffing the stuff that is in the can. When opening a can of Zyvax for the first time, just punch a hole in the seal inside the can. There is no reason to remove the whole seal, as having a small pouring hole is very handy. When putting it on the rag, unscrew the lid, put the rag over the opening, and tilt the can until it starts to get the rag wet. This keeps any more air than necessary from getting in the can, and also keeps people from soaking the rags with it. Applying Zyvax does not require soaking a rag in it first, nor does it require being poured all over the tool in a big puddle.

7.8 What is the shelf life of the Zyvax products?

When I asked the Zyvax folks about this, they said it was a pretty long time, so long as the cans stay sealed. Apparently they have had stuff around their shop for several years that keeps working. If you have a doubt, try it on a smaller part of something, and then see if it will release before trying something large.

As the cans get more and more empty, they start to go off faster, as there is more air in the container, and it mixes more when you get it out. Both SealerGP and CompositeShield, when applied to the tool for the wipe on, wipe-off, should lay as a shiny wet layer before wiping off. If it does not soak in, but appears instead to go off quickly on the tool, then it probably means that the can is nearing the end of its life. When the wipe on stage occurs, the material should remain shiny for about 40 seconds. The quicker it goes off, the more close it is to the end of its life. Do not try and use Zyvax if it goes off as it is rubbed on, and do not let the Zyvax go off while on the tool. It needs to be wiped off while still wet.

7.9 What about pin holing?

Pin holing in plugs makes it annoying to get the mold off. However, you can still get the mold off the plug. This needs wedges, unfortunately, as the pin holing in the plug will fill up with resin. You will end up with a tool with a gritty feeling surface. A nice wet sanding will fix that up. I used 400, 800, 1000, and 1200 with water, and it shined up brilliantly, even though we had a pin holy mess on the plug and the releasing was relatively difficult.

7.10 What do I do to clean residue (say excess gel coat) off a tool that has been used recently?

If there are multiple parts coming out of a tool, and for whatever reason there is resin or something left behind on the tooling surface, it will need to be cleaned. If it comes off easily enough, use your fingernails, a plastic scraper, or else softer than the tooling surface. If you need to use chemicals to get it off, then you will most likely take off the Zyvax, and require re-seasoning the tool as outlined above. The following chemicals are known to remove Zyvax:

- Fresh Start
- Acetone
- Methylated Spirits (Ethanol)
- Sandpaper
- Gasoline
- Kerosene

The following are thought to remove Zyvax, and should be checked before use-

- Dish detergent (if scrubbed harsh enough- It takes car wax off, too, by the way)
- Bad personalities
- Any chemical that smells bad or has grit in it
- People who do not trust Zyvax

7.11 How do I know if there is Zyvax on a tool?

Zyvax, when applied properly will not look glassy when it is dry. In fact, tools that have been treated with the Zyvax system look almost identical to tools that have not. If wax is applied to a surface, it will look shiny and waxed. Zyvax does not do that. However, a tool treated with Zyvax will cause water to bead. Therefore, a quick and easy test would be to drip some water on the tool. If it beads, then the tool may have been treated. Another simple test to see if the

coating is there is to try and stick something to it. Dum-dum and flash tape will not stick to Zyvax very well. Normal sticky tape, like gaffa and normal clear tape, do stick to Zyvax, so be careful of the tape test. To be totally sure, use the test procedure described below.

Before laying up, if there is any doubt, follow the procedure described under "How do I test the tool to make sure the Zyvax is okay?"

7.12 How do I test the tool to make sure the Zyvax is okay?

The easiest and most reliable way to do this is mix up some epoxy and try it out. I find the best way to do this is to mix up a really small batch and stick a paddle pop stick to the surface of the tool, in an easy to repair place. Let the epoxy go off (Use fast hardener if it is available), and then remove the stick. You should have left part of the paddle pop stick hanging off the side of the tool, so that you have a small lever to release it with. If it just pops right up with very little effort, then the release agent is okay. If it does not come up real easy, then the only part you have to fix is wherever you stuck the stick, rather than the entire tool. Testing is good. Even if it delays things, if there is doubt of the quality of the release, then it should be done.

7.13 How do I sand a finished tool?

Should you ever have to sand a tool, which you should never have to do unless you are repairing it, do it wet. Wet sanding on a fiberglass tool is much better than dry sanding. The paper does not clog up, the dust stays under control, and the surface finish turns out much better. For wet sanding, just dump water over the surface of the mold, and start going. We have actually used a stiff wire brush to remove crud off the inside of a finished low temp tool, which resulted when someone accidentally sanded off the Zyvax. The wire brush did not scratch the tooling surface that bad, where it was brushed wet. Test any sanding/scraping in a small unimportant part of the tool before going to town on it, and do all sanding and gritty work with a wet tool.